



EMERGING COMMUNICATION TECHNOLOGIES (ECT) PHASE 2 REPORT Volume 2 APPENDICES

Gary L. Bastin, Ph.D.
ASRC Aerospace Corporation, John F. Kennedy Space Center, Florida

William G. Harris, PE
ASRC Aerospace Corporation, John F. Kennedy Space Center, Florida

Robert Chiodini
ASRC Aerospace Corporation, John F. Kennedy Space Center, Florida

Richard A. Nelson
NASA, YA-D7, John F. Kennedy Space Center, Florida

PoTien Huang
NASA, YA-D5, John F. Kennedy Space Center, Florida

David A. Kruhm
NASA, YA-D5, John F. Kennedy Space Center, Florida

The NASA STI Program Office . . . in Profile

Since its founding, NASA has been dedicated to the advancement of aeronautics and space science. The NASA Scientific and Technical Information (STI) Program Office plays a key part in helping NASA maintain this important role.

The NASA STI Program Office is operated by Langley Research Center, the lead center for NASA's scientific and technical information. The NASA STI Program Office provides access to the NASA STI Database, the largest collection of aeronautical and space science STI in the world. The Program Office is also NASA's institutional mechanism for disseminating the results of its research and development activities. These results are published by NASA in the NASA STI Report Series, which includes the following report types:

- **TECHNICAL PUBLICATION.** Reports of completed research or a major significant phase of research that present the results of NASA programs and include extensive data or theoretical analysis. Includes compilations of significant scientific and technical data and information deemed to be of continuing reference value. NASA's counterpart of peer-reviewed formal professional papers but has less stringent limitations on manuscript length and extent of graphic presentations.
- **TECHNICAL MEMORANDUM.** Scientific and technical findings that are preliminary or of specialized interest, e.g., quick release reports, working papers, and bibliographies that contain minimal annotation. Does not contain extensive analysis.
- **CONTRACTOR REPORT.** Scientific and technical findings by NASA-sponsored contractors and grantees.
- **CONFERENCE PUBLICATION.** Collected papers from scientific and technical conferences, symposia, seminars, or other

meetings sponsored or cosponsored by NASA.

- **SPECIAL PUBLICATION.** Scientific, technical, or historical information from NASA programs, projects, and mission, often concerned with subjects having substantial public interest.
- **TECHNICAL TRANSLATION.** English-language translations of foreign scientific and technical material pertinent to NASA's mission.

Specialized services that complement the STI Program Office's diverse offerings include creating custom thesauri, building customized databases, organizing and publishing research results . . . even providing videos.

For more information about the NASA STI Program Office, see the following:

- Access the NASA STI Program Home Page at <http://www.sti.nasa.gov>
- E-mail your question via the Internet to help@sti.nasa.gov
- Fax your question to the NASA STI Help Desk at (301) 621-0134
- Telephone the NASA STI Help Desk at (301) 621-0390
- Write to:

NASA STI Help Desk
NASA Center for AeroSpace Information
7121 Standard Drive
Hanover, MD 21076-1320



EMERGING COMMUNICATION TECHNOLOGIES (ECT) PHASE 2 REPORT Volume 2 APPENDICES

Gary L. Bastin, Ph.D.
ASRC Aerospace Corporation, John F. Kennedy Space Center, Florida

William G. Harris, PE
ASRC Aerospace Corporation, John F. Kennedy Space Center, Florida

Robert Chiodini
ASRC Aerospace Corporation, John F. Kennedy Space Center, Florida

Richard A. Nelson
NASA, YA-D7, John F. Kennedy Space Center, Florida

PoTien Huang
NASA, YA-D5, John F. Kennedy Space Center, Florida

David A. Kruhm
NASA, YA-D5, John F. Kennedy Space Center, Florida

**National Aeronautics and
Space Administration**

John F. Kennedy Space Center, Florida 32899-0001

Acknowledgments

Although there is always the risk of inadvertently forgetting someone, the ECT team nonetheless wishes to acknowledge especially the assistance and guidance provided by the following individuals, listed alphabetically. Without the continued support of these supporters who believed in the value of this project, this project could not have accomplished all its goals.

<u>Name</u>	<u>Organization</u>
Hugo Delgado	NASA-KSC
Eric Denson	NASA-KSC
Temel Erdogan	Dynacs
Mike Grant	CSR-Tel-4
Debra Holiday	FL Space Authority
Don Hoover	CSR-Optics
Gary Janousek	CSR-XY
Chris Kerios	Dynacs
Ray Knighton	ITT-SLRSC
Dennis McCunnion	CSR-TVOC
Jules McNeff	NASA-HQ
Rich Nelson	NASA-KSC
Don Philp	Dynacs
John Rush	NASA-HQ
Jim Shaver	NASA-Hanger AE
Steve Schaefer	Dynacs
Steve Schindler	NASA-KSC
Darin Skelly	NASA-KSC
Stan Starr	Dynacs
Dave Struba	NASA-HQ
Lisa Valencia	NASA-KSC
John Walker	CSR-JDMTA
Phil Weber	NASA-KSC

Available from:

NASA Center for AeroSpace Information
7121 Standard Drive
Hanover, MD 21076-1320

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161

Table of Contents

APPENDIX A	WI-FI TEST PLAN - DRAFT	1
1.0	INTRODUCTION	3
1.1	Intended Readership.....	3
1.2	Document Applicability.....	3
1.3	Document Purpose	3
1.4	How to Use This Document.....	3
1.5	Reference Documents	3
1.6	Conventions	4
1.7	Overview.....	4
1.8	Scope.....	4
2.0	TEST PLAN	5
2.1	Objectives	5
2.2	Test Resources	5
2.3	Features to be Tested	6
2.4	Features Not To Be Tested	7
2.5	Approach.....	7
2.6	Pass/Fail Criteria.....	11
2.7	Suspension Criteria and Resumption Requirements	11
2.8	Test Deliverables	12
2.9	Test Tasks	12
2.10	Environmental Needs.....	12
2.11	Risks and Contingencies.....	12
2.12	Approvals.....	13
3.0	GLOSSARY	14
APPENDIX B	WI-FI TEST PROCEDURES - DRAFT.....	15
1.0	INTRODUCTION	17
1.1	Background.....	17
1.2	Scope.....	17
1.3	References.....	17
2.0	GENERAL TEST PROCEDURES	17
2.1	Personnel.....	17
2.2	Schedule.....	17
2.3	Test Resources	18
2.4	Results.....	19

3.0	DETAILED TEST PROCEDURES	20
3.1	TEST 1: Initialize EDL-lab1	21
3.2	TEST 2: Initialize EDL-lab2.....	22
3.3	TEST 3: Baseline Performance Distribution (25 Ft).....	23
3.4	TEST 4: Wi-Fi Performance With Antenna Position.....	25
3.5	TEST 5: Wi-Fi Performance With Distance (EDL-lab1).....	27
3.6	TEST 6: Performance With Attenuation (EDL-lab1)	29
3.7	TEST 7: Wi-Fi Performance With INTERFERENCE (EDL-lab1)	32
4.0	GLOSSARY	35
APPENDIX C	WI-FI TEST RESULTS.....	37
1.0	TEST 1: SET-UP, FUNCTION & INTEROPERABILITY (EDL-LAB1).....	38
2.0	TEST 2: SET-UP, FUNCTION & INTEROPERABILITY (EDL-LAB2).....	39
3.0	TEST 3: BASELINE PERFORMANCE AT 25 FT	40
4.0	TEST 4: WI-FI PERF. VS ANTENNA POSITION (SUMMARY).....	42
4.1	TEST 4.1: Antenna Rear, 12:00.....	44
4.2	TEST 4.2: Antenna Rear, 10:30.....	46
4.3	TEST 4.3: Antenna Rear, 9:00.....	48
4.4	TEST 4.4: Antenna Rear, 7:30.....	50
4.5	TEST 4.5: Antenna Rear, 6:00.....	52
4.6	TEST 4.6: Antenna Front, 6:00.....	54
4.7	TEST 4.7: Antenna Front, 4:30.....	56
4.8	TEST 4.8: Antenna Front, 3:00.....	58
4.9	TEST 4.9: Antenna Front, 1:30.....	60
4.10	TEST 4.10: Antenna Front, 12:00.....	62
5.0	TEST 5: PERFORMANCE VERSUS DISTANCE	64
5.1	TEST 5.1: Performance Vs Distance (EDL-lab1).....	64
5.2	TEST 5.2: Performance Vs Distance (EDL-Lab2)	76
5.3	TEST 5.3: Performance With Two Base Stations At 25 & 50 Ft	88
6.0	TEST 6: WI-FI PERFORMANCE WITH ATTENUATION BARRIERS	91
6.1	TEST 6.1: Wi-Fi Performance With One Partition.....	92
6.2	TEST 6.2: Wi-Fi Performance With Two Partitions.....	96
6.3	TEST 6.3: Wi-Fi Performance With .125-inch Al Sheet	100
6.4	TEST 6.4: Wi-Fi Performance With .187-inch Al Sheet	104
6.5	TEST 6.5: Wi-Fi Performance With .062-inch Steel Sheet	108
6.6	TEST 6.6: Wi-Fi Performance With Cinder Blocks (3 h, 1 w, 1 t).....	112
6.7	TEST 6.7: Wi-Fi Performance With Cinder Blocks (3 h, 1 w, 2 t).....	116
6.8	TEST 6.8: Wi-Fi Performance With Cinder Blocks (3 h, 2 w, 1 t).....	120

6.9	TEST 6.9: Wi-Fi Performance With Human barrier	124
7.0	TEST 7: WI-FI PERFORMANCE WITH INTERFERENCE.....	128
7.1	TEST 7.1: Wi-Fi Performance With UWB	128
7.2	TEST 7.2: Wi-Fi Performance With Microwave Oven	132
7.3	TEST 7.3: Wi-Fi Performance With 2.4 GHz Cordless Phone.....	136
7.4	TEST 7.4: Wi-Fi Performance With Cell Phone.....	140
7.5	TEST 7.5: Wi-Fi Performance With Aircraft Nav Radio	144
7.6	TEST 7.6: Wi-Fi Performance With Aircraft Com Radio	147
7.7	TEST 7.7: Wi-Fi Performance With GPS RECEIVER	150
7.8	TEST 7.8: Wi-Fi Performance With Iridium Phone	154
8.0	TEST 8: WI-FI PERF COMPARISON OF 802.11B AND 802.11G	158
APPENDIX D	UWB TEST PROCEDURE.....	167
1.0	INTRODUCTION	169
2.0	TEST DESCRIPTION.....	169
3.0	REQUIRED EQUIPMENT	169
4.0	TEST PROCEDURES.....	170
4.1	Time Domain EVK Software Configurationults.....	171
4.2	Range Vs. Data Rate Tests.....	172
4.3	InterFERENCE From Other Devices Vs. Data Rate Vs Range.....	182
4.4	Link Margin vs. Data Rate vs. Range	203
4.5	Interference with Other Devices vs. Data Rate vs. Range	217
4.6	Gross Conformance to FCC Part 15 Subpart F Parg (3) Radiated Emissions Mask	218
5.0	TEST COMPLETION.....	222
6.0	ACRONYMS.....	222
APPENDIX E	FSO TEST PLAN	223
1.0	INTRODUCTION	225
1.1	Intended Readership.....	225
1.2	Document Applicability	225
1.3	Document Purpose	225
1.4	How to Use This Document.....	225
1.5	Reference Documents	226
1.6	Conventions	226
1.7	Overview.....	226
1.8	Scope.....	226
2.0	TEST PLAN	228
2.1	Objectives	228

2.2	Test Resources	228
2.3	Features to be Tested	229
2.4	Features Not To Be Tested	230
2.5	Approach.....	230
2.6	Pass/Fail Criteria.....	234
2.7	Suspension Criteria and Resumption Requirements	234
2.8	Test Deliverables	235
2.9	Test Tasks	235
2.10	Environmental Needs.....	235
2.11	Risks and Contingencies.....	235
2.12	Approvals.....	235
3.0	GLOSSARY	236
APPENDIX F	FSO TEST PROCEDURE	237
1.0	INTRODUCTION	239
1.1	Background.....	239
1.2	Scope.....	239
1.3	References.....	240
2.0	GENERAL TEST PROCEDURES	241
2.1	Personnel.....	241
2.2	Schedule.....	241
2.3	Test Resources	241
2.4	Results.....	242
3.0	DETAILED TEST PROCEDURES	244
3.1	TEST 1: Set-Up, Functionality & Interoperability.....	245
3.2	TEST 2: Reliability & Weather Effects	245
3.3	TEST 3: Remote Testing	246
3.4	TEST 4: Medium Distance Testing	246
4.0	GLOSSARY	247
APPENDIX G	FSO TEST RESULTS.....	249
1.0	TEST 1: SIGNAL STRENGTH.....	249
2.0	TEST 2: THROUGHPUT AND PACKET LOSS.....	252
APPENDIX H	FSO NOTES	253
1.0	GENERAL INFORMATION	256
2.0	CAMLAP OPERATIONS.....	258
2.1	CamLAP Logon.....	258

2.2	CamLAP Logout.....	259
2.3	OTU Initialization.....	260
2.4	OTU Restart.....	262
2.5	Set OTU to Stare.....	264
2.6	Set OTU to Scan	265
2.7	Check Data Link	266
3.0	OTU OPERATIONS – INTERNET EXPLORER.....	267
3.1	IE Logon	267
3.2	IE Logout	268
3.3	Check OTU IP Address	269
3.4	Change OTU IP Address	270
3.5	Set Commission Flag (True / False)	271
3.6	Check Data Link Status	272
4.0	OTU OPERATIONS – HYPERTERMINAL.....	273
4.1	HyperTerminal Logon - Ethernet.....	273
4.2	HyperTerminal LOGON – RS232	274
4.3	HyperTerminal LOGOUT	276
4.4	Change OTU IP Address	277
4.5	Measure Transmit & Receive Power	278
4.6	Check Data Link Status	279
5.0	SMARTBITS OPERATIONS.....	280
5.1	SmartBits LOGON	280
5.2	Setup Test Links	282
5.3	Setup Test Configuration	285
5.4	Run Tests	286
5.5	Typical Data.....	288
6.0	LAPTOP OPERATIONS.....	289
6.1	Notes	289
6.2	Set Laptop IP Address	290
6.3	Check Laptop IP Address	291
6.4	Turn Off Wi-Fi.....	292
6.5	Verify Communication Link Is Established.....	293

APPENDIX A

WI-FI TEST PLAN - DRAFT

Report No. ECT-T-003

Wireless
Ethernet
(Wi-Fi)

Test Plan

Bill Harris

This document identifies tests to be conducted on and with Wireless Ethernet equipment manufactured by Gateway Computers and Microsoft. This Test Plan format is per standard IEEE recommendations. This document was prepared as part of the FY03 task 6CRG331.

Version: 0.1

Issued By: Range Group

Date: 03 April 2003

Approved By: _____

Task Lead

USTDC Group Manager

USTDC Department Director

NASA Project Manager

Table of Contents

**(Individual Table of Contents had to be removed to avoid conflicts with
Volume 2's overall Table of Contents)**

1.0 INTRODUCTION

1.1 INTENDED READERSHIP

The audience for this test plan includes, but is not restricted to, the following personnel:

- USTDC staff responsible for performing Wi-Fi testing
- USTDC management responsible for Wi-Fi testing supervision
- NASA management responsible for Wi-Fi testing oversight
- Communication Engineers at NASA KSC interested in Wi-Fi technology for possible future use at KSC
- Communication Engineers and Policy Makers throughout NASA interested in Wi-Fi technology

1.2 DOCUMENT APPLICABILITY

This test plan applies to a built-in wireless Ethernet module available from Gateway Computers of San Diego, California and to a Wireless Base Station manufactured for Microsoft Corporation, Redmond, Washington.

1.3 DOCUMENT PURPOSE

This test plan is a guide to the evaluation tests to be conducted with the Wi-Fi Equipment available from Gateway and Microsoft corporations. It outlines the types of tests to be carried out, identifies the features to be tested, and establishes pass and fail criteria.

1.4 HOW TO USE THIS DOCUMENT

This plan is to be used by those responsible for testing, and by those responsible for approving the tests, to ensure that all features that need to be tested are subjected to tests, in accordance with the requirements established in the task order documentation. This test plan should be regarded as being a guide to the test plan phase of the task order, rather than as being a detailed test procedure. A separate document will contain the detailed test procedures.

1.5 REFERENCE DOCUMENTS

This test plan is a part of the FY03 Emerging Communication Technology (ECT) task order. This task orders should be read and considered while evaluating this test plan, to guarantee that all requirements are met. The other major document files are the Gateway documentation, available with the Laptop Computer and Microsoft documentation available with the Base Station system. Together, these documents should be used to evaluate this test plan. The full list of applicable documents is as follows:

- [1] USTDC Task Order, Reference: 6CRG331; Emerging Communications Technology (ECT)
- [2] Gateway DS 450 X laptop internal help documentation
- [3] Microsoft Wireless Base Station MN-500 User's Guide
- [4] Wireless Ethernet Test Procedure (ECT-T-004)

1.6 CONVENTIONS

There are no unusual stylistic and command syntax conventions used in communicating with the interfaces of the Wi-Fi equipment. Interfaces that will be used during these tests are as follows:

- Gateway laptop: Ethernet RJ-45
- Microsoft Wireless Base Station: Ethernet RJ-45

1.7 OVERVIEW

This test plan covers performance and feature testing of the Microsoft Base Station MN-500, MN-500 software, Gateway DS45X Laptop, and user interfaces. Its purpose is to evaluate if the equipment meets key requirements necessary for future incorporation of Wi-Fi technology at KSC.

1.8 SCOPE

Wi-Fi testing will be limited as follows:

1.8.1 Test Items

Testing will be limited to one Gateway DS450X laptop computer and two Microsoft Wireless Base Stations, MN-500.

1.8.2 Test Purpose

This plan covers only the initial evaluation of the available hardware and software; it does not address acceptance testing.

1.8.3 Test Locations

Testing locations will normally be limited to one laboratory and other areas of the Engineering Development Laboratory (EDL) at KSC. Other KSC and CCAFS areas may be considered if they offer an advantage.

1.8.4 Attenuation

Attenuation tests may be limited to three normal interior building materials.

1.8.5 Interference

Interference tests may be limited to three RF sources.

2.0 TEST PLAN

Wireless Ethernet (Wi-Fi) is an emerging communication technology that holds great promise for the fast installation of communication links, both voice and/or data, at moderate data rates over short distances. Wi-Fi uses a wireless protocol called IEEE 802.11b or Wi-Fi (Wireless-Fidelity). Wi-Fi offers the convenience of a wireless LAN that can support wireless laptops, PDAs, and other devices within a small area. In addition, Wi-Fi offers the ability to have a wireless/fiberless connection in mobile or extreme environments where physical contact can present engineering challenges. The communication capabilities inherent with Wi-Fi equipment are likely to be of great benefit to business, public safety, consumer applications, and Government needs for varied tasks ranging from high data rate communications to mobile transport LAN links. Because of this widespread benefit, it is necessary to assess the inherent capabilities of Wi-Fi technology for direct use at KSC.

Since Wi-Fi is susceptible to attenuation due to walls and barriers, and may be influenced by RF radiation from other home and offices sources, detailed testing is needed to measure technical parameters and to assess Range usefulness.

The goal of this test plan is to address these key concerns in both a quantitative and qualitative fashion, and to assess whether Wi-Fi communication systems are practically for unique Range communication systems. Additionally, the capability of Wi-Fi communication equipment to transport Ethernet data must be investigated to assess the robustness of Wi-Fi communication signals. This test plan identifies the tests to accomplish these goals.

2.1 OBJECTIVES

The testing objectives are as follows:

- Evaluate COTS Wi-Fi equipment for possible future use at KSC
- Identify any fundamental shortcomings that must be filled in commercial Wi-Fi communication technologies prior to integrating functions into an integrated future data

2.2 TEST RESOURCES

2.2.1 Test Item

Test items are as follows:

- Gateway DS 450 X laptop computer
- Gateway operational software
- Microsoft Wireless Base Station MN-500
- Microsoft Set-up and Network Software (MN-500)

2.2.2 Test Facilities

Test facilities will include the following:

- Advanced Network Development Lab (EDL Bld, Rm 124)
- EDL Building

2.2.3 Test Equipment

Test equipments will include the following:

- Gateway laptop built-in diagnostic software
- SmartBits 2000 with appropriate plug-ins

Other test equipment may be utilized as need and when appropriate.

2.2.4 Support Organizations

The following support organizations may be utilized in setting up for the test:

- NASA-KSC Frequency Spectrum

2.3 **FEATURES TO BE TESTED**

The test plan assumes that the following features of the Wi-Fi are to be tested:

2.3.1 Hardware Functionality

Testing will evaluate if major features of the hardware operate within pre-determined parameters.

2.3.2 Software Functionality

During testing, software will be evaluated to see if it works as intended, without glitches and lock-ups.

2.3.3 Conformance

Testing will determine if equipment conforms to current industry standards for inputs and outputs.

2.3.4 Interoperability

System testing within a network will determine if the Wi-Fi equipment operates as expected.

2.3.5 Throughput Performance

Performance testing will measure Data Rate, SNRs, Signal Levels, and Noise Levels of both the Base Station and the Laptop as a function of:

- Range
- Attenuation
- Interference
- WEP (Encryption) settings

2.4 FEATURES NOT TO BE TESTED

2.4.1 Safety

Operational safety testing is not a part of this test plan. The test items previously identified are UL approved. If any unsafe conditions are identified during routine testing, they will be noted in the marked-up Test Procedures and discussed in the Final Report.

2.4.2 Environmental Requirements

Environmental exposure testing is not a part of this test plan. The ability of the equipment to function long term in a coastal environment is not a specific test parameter; however, if equipment degradation is observed, it will be noted in the marked-up Test Procedures and discussed in the final report. Subsequent testing of operational units under environmental extremes may be recommended.

2.4.3 Long-term Reliability

It will ultimately become a requirement that fielded systems must show an acceptably low number of failures of the software and hardware averaged over a significant period. This can only be tested in regular and extended use of the equipment, and so shall not form part of the test plan for this task, which concentrates on fundamental feasibility and applicability of the technology and not of a particular implementation.

2.5 APPROACH

Tests will be performed in accordance with the requirements identified in this Test Plan. Significant problems encountered during testing will be recorded for documenting any failures or problems, even where these problems are agreed as non-critical.

2.5.1 Detailed Test Configurations

Performance testing will utilize the following configuration:

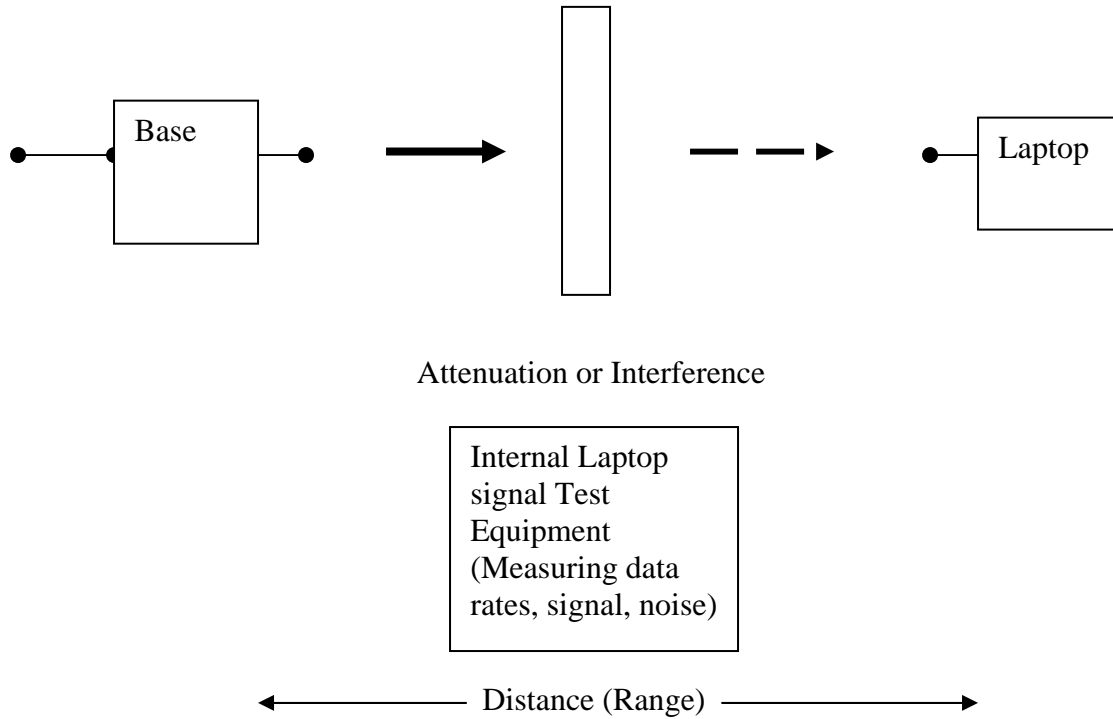


Figure 2-1
Wi-Fi Test Configuration

2.5.2 Test Parameters

Testing parameters will include the following:

- Hardware/Software functionality – Evaluate following features:
 - ◆ Loading wireless software on laptop
 - ◆ Setting-up and configuring the Wireless Base Station
 - ◆ Interconnection and compatibility with LAN
 - ◆ Time to acquire link with Base Station
 - ◆ Connect to WWW
- Software functionality – Secondary result of all testing

- Conformance – Secondary result of all testing
- Interoperability – Secondary result of all testing
- Throughput performance – Per following test parameters and table:
 - ◆ Independent Variables
 - Distance
 - Attenuation (interior wall(s), exterior wall, cinder blocks)
 - Interferences (microwave oven, GPS receiver, cordless phone)
 - Security (40 bit WEP, 128 bit WEP)
 - ◆ Dependent variables
 - Data Rates (Up to 11 Mbps)
 - SNR (Laptop)
 - Signal strength (Laptop)
 - Noise strength (Laptop)
 - SNR (Base Station)
 - Signal strength (Base Station)
 - Noise (Base Station)

Table 2-1 Wi-Fi Test Plan Configurations

Tests	Range (ft.)	Atten.	Interference	Measured Parameters	Comments
Functionality of Base Station #1	10 ft	none	none	Pass/Fail	Evaluate configurati on process
Functionality of Base Station #2	10 ft	none	none	Pass/Fail	Evaluate configurati on process
Baseline Performance Station #1	10, 20,40, 60, 80,100 , max	none	none	Data rate, SNR, Signal, Noise	Record data for both Base Station & Laptop
Baseline Performance Station #2	10, 20,40, 60, 80,100 , max	none	none	Data rate, SNR, Signal, Noise	Record data for both Base Station & Laptop
Performance With Attenuation	10, 20,40, 60, 80,100 , max	Variou s buildin g materi als	none	Data rate, SNR, Signal, Noise	Record data for both Base Station & Laptop
Performance With Interference	10, 20,40, 60, 80,100 , max	none	Various interference sources	Data rate, SNR, Signal, Noise	Record data for both Base Station & Laptop
Performance With WEP	10, 20,40, 60, 80,100 , max	none	none	Data rate, SNR, Signal, Noise	Vary encryption at 128, 64, and none

2.6 PASS/FAIL CRITERIA

Different features of the Wi-Fi will have different pass/fail criteria according to the requirements that must be satisfied. Maximum length will be measured at 12 dB. The Wi-Fi will be judged to have passed user interface criteria if no critical problems that relate to the test have occurred. The criteria for criticality are as follows:

- Critical failures include crash, incorrect results, and unsafe behavior
- Non-critical failures will include any failure to meet a non-essential requirement

2.6.1 Hardware Functionality

This should be demonstrated using the test procedures in Reference [4].

2.6.2 Software Functionality

This should be demonstrated using the test procedures in Reference [4], based upon pass/fail on simple functionality tests, i.e. does the item (do the items) perform the basic functionality that is required?

2.6.3 Conformance

Communication with and/or via interfaces will demonstrate conformance to industry standards on data rates and protocols.

2.6.4 Interoperability

Communication with other network equipment will be demonstrated by the test procedures in Reference [4], based upon pass/fail on simple functionality tests.

2.6.5 Performance

Performance acceptance criteria will be identified in the test procedures in Reference [4].

2.7 SUSPENSION CRITERIA AND RESUMPTION REQUIREMENTS

Any test should be suspended in the event of failure to meet the requirement, or in the event of causing untoward interference with licensed radio services. A suspended test should only be resumed if project lead and appropriate management can agree on either

- A course of action to remedy the problem, or
- The relaxation of a requirement to allow testing to continue has no implication for the overall performance of the system, or

If none of the above is possible, the test will be deemed to have failed, and the testing should progress to the next test if this is possible given the previous failure(s).

2.8 TEST DELIVERABLES

2.8.1 Prior to testing

Before testing starts, the project lead will ensure that the following items are made available to all members of the test team:

- Test Plan
- Test Procedures

The following items will be available for reference in the EDL laboratory:

- Wi-Fi Documentation provided by Microsoft on the Wireless Base Station MN-500
- Wi-Fi Documentation provided within the help function on the Gateway Laptop

2.8.2 After Testing

When testing ends, the following data items will be generated and made available as a part of testing:

- Test Procedure results

No post-test processing is anticipated.

Testing results, analysis, conclusions and recommendations will be the main topics of the ECT Final Report.

2.9 TEST TASKS

In preparation for carrying out the tests, it will be necessary to ensure that the full Wi-Fi system is operational. Since the Base Stations are programmed via laptops, suitable cables must be in place. An internet connection to the WWW, through a lab router, will also be necessary.

2.10 ENVIRONMENTAL NEEDS

Testing will be conducted initially in lab conditions.

2.11 RISKS AND CONTINGENCIES

The need to keep the Base Station connected to an EDL router may limit the locations available for testing. This may limit testing of cell phones, Iridium phone, portable phone, GPS and other items that need to be clear of the building to receive a good signal from their sources. The test procedures will be adjusted as necessary to investigate these devices.

2.12 APPROVALS

This plan is to be reviewed as it develops through the initial test phases of the task order, and, following review, is to be submitted for approval by the NASA Project Manager.

3.0 GLOSSARY

The following acronyms and abbreviations are used in this document:

ASRC	Artic Slope Regional Corporation
CCAFS	Cape Canaveral Air Force Station
COTS	Commercial Off The Shelf
ECT	Emerging Communication Technology
EDL	Engineering Development Laboratory Building
FY	Fiscal Year (Oct-Sept)
IEEE	Institute of Electrical & Electronic Engineers
KSC	Kennedy Space Center
LAN	Local Area Network
Latency	Time for one-way travel from sender to receiver
Mbps	Million Bits Per Second
Rcvr	Receiver
SNR	Signal to Noise Ratio
USTDC	University-Affiliated Spaceport Technology Development Contract
WEP	Encryption code key (26 characters = 128 bit encryption)
Wi-Fi	Wireless-Fidelity (Wireless Ethernet)
WWW	World Wide Web
Xcvr	Transceiver

APPENDIX B WI-FI TEST PROCEDURES - DRAFT

**Wireless
Ethernet
(Wi-Fi)**

Report No. ECT-T-004

Test Procedures

Bill Harris

This document identifies tests procedures to be conducted on and with Wireless Ethernet equipment manufactured by Gateway Computers and Microsoft. This Test Procedure provides the testing details that were outlined in the Wi-Fi Test Plan. This document was prepared as part of FY03 task 6CRG331.

Version: 0.1

Issued By: Range Group

Approved By:

Date: 27 March 2003

Task Lead

USTDC Group Manager

USTDC Department Director

NASA Project Manager

Table Of Contents

(Individual Table of Contents had to be removed to avoid conflicts with Volume 2's overall Table of Contents)

1.0 INTRODUCTION

1.1 BACKGROUND

This test plan is a part of the FY03 Emerging Communication Technology (ECT) task order. This task involves evaluating three evolving communication technologies for possible use on the Range. This series of test procedures will be evaluating the following Wireless Ethernet (Wi-Fi) equipment:

- Gateway DS 450 X laptop computer
- Microsoft MN-500 Wireless Base Station (Access Point)

1.2 SCOPE

Testing will be limited to one Gateway laptop and two Base Station shown above and to evaluating the following:

- Performance
- Attenuation
- Interference

1.3 REFERENCES

- [1] Wi-Fi Test Plan (ECT-T-003)
- [2] USTDC Task Order, Reference: 6CRG331; Emerging Communications
- [3] Technology (ECT)
- [4] Gateway DS 450 X embedded help software
- [5] Microsoft Wireless Base Station MN-500 User's Guide

2.0 GENERAL TEST PROCEDURES

2.1 PERSONNEL

The test team will consist of all or part of the following personnel:

- Test coordinator – leader of test activities
- Test assistant(s) – assist the test coordinator in functions requiring more than one person.
- QA buy-off is not required for these evaluation tests.

2.2 SCHEDULE

The test schedule will be defined at the project level.

2.3 TEST RESOURCES

2.3.1 Test Items

Test items are as follows:

- Gateway DS 450 X laptop computer
- Gateway 450 SX4 User Guide, 10/20/2002
- Microsoft Wireless Base Station MN-500
- Microsoft Set-up and Network Software, 1.08.003 Version 2.11.15.0

2.3.2 Test Facilities

Test facilities include the following:

- Advanced Network Development Lab (ANDL), EDL Bld, Rm 124
- Engineering development Lab (EDL) Building

2.3.3 Test Equipment

Test equipment may include the following:

- Gateway laptop built-in diagnostic software
- SmartBits 2000 with appropriate plug-ins

Other test equipment may be utilized as needed and when appropriate.

2.3.4 Support Organization

The following support organizations may be utilized in setting up for the test:

- NASA-KSC Frequency Spectrum

2.4 RESULTS

2.4.1 Background Data

The following Background Data shall be recorded for all tests:

- Date
- Time
- Location
- Test coordinator
- Any test personnel (if appropriate)
- Hardware
- Test equipment
- Calibration dates

2.4.2 Test Data

Test Data shall be recorded on the sheets provided in Section 3 or other suitable forms.

2.4.3 Anomalies

All anomalies witnessed during checkout, set-up or testing shall be recorded and described in the comments section of the Data Sheet or on another suitable form. The full description should include, as a minimum, the following:

- Test configuration
- Test hardware being used
- Test equipment and calibration date
- Sub-test or operation being attempted
- Indication of anomaly
- Test conductor
- Any test personnel or witnesses to the anomaly
- Date
- Time of day

2.4.4 Safety

Any product safety issues that appear during checkout, set-up or testing shall be documented in the comments section of the Data Sheet or within another suitable document. The issue and supporting data shall be described in full detail sufficient for someone else to repeat the observation.

3.0 DETAILED TEST PROCEDURES

Testing procedures and Data Sheets are included in the following sections.
Computers refer to the two Laptop computer purchased by ECT for the project as follows:

Keeper	MAC #	IP
#BH - Bill Harris	00-02-2D-6E-A2-F4	128.217.107.174
#GB – Gary Bastin	00-02-2D-6E-5B-7E	128.217.107.175

Base stations refer to the two Microsoft MN-500 units purchased by ECT for testing as follows:

Title	Floor	Room	MAC	IP	Ch
EDL-lab1	1	124	00-50-F2-C7-21-6C	128.217.107.200	6
EDL-lab2	2	240	00-50-F2-C7-C5-6C	128.217.107.201	7
EDL-lab3	2	240	00-40-05-2a-9f-22	128.217.107.202	8

For all tests, confirm the following settings except as noted in test procedures:

1. Double click on MSBNUtil.exe
2. Select “TOOLS”
3. Select “Base Station Management Tool”
4. Login “ECT-01”
5. Select “Security”
6. Wireless: Security on
7. Network Mode: Routing Mode
8. Firewall On Discard Pings Off
9. Port Forwarding NA
10. Virtual DMZ NA
11. MAC Filtering Off
12. Client Filtering Off
13. Encryption 128

3.1 TEST 1: INITIALIZE EDL-LAB1

OBJECTIVE: Test the set-up procedures, functionality, and interoperability for the Microsoft Wireless base Station MN-500 and the Wi-Fi hardware/software built-in to the Gateway laptop.

Test	1		
Date:	2/17/03 & 3/6/03	Time:	0900 & 1300
Location:	EDL Advanced Network Development Lab, Rm 124		
Test Coordinator:	W. G. Harris		
Test Personnel:	Dave Miller		
Hardware (LT/BS)	#BH	EDL-lab1	
Address	00-02-2D-6E-A2-F4	00-50-F2-C7-21-6C	
Height:	3-ft	5-ft	
Encryption (WEP):	128 bit	Firewall:	On
Test Equipment:	Laptop #BH	Cal:	none

Set-up and Checkout of EDL-lab1

	<u>Pass</u>	<u>Fail</u>
Using instructions in Reference [4], perform the following test:		
A. Load software on to a laptop. Successful?	<u>X</u>	
B. Power up and configure the base station. Successful?	<u>X</u>	
C. Connect base station to LAN through lab router. Successful?	<u>X</u>	
D. Disconnect laptop cable to base station, and reconnect with wireless link. Successful?	<u>X</u>	
E. Time to acquire link? <u>10 sec</u> sec.		
F. Connect to WWW through wireless link. Successful?	<u>X</u>	
G. Measure distance, laptop to base station <u>5</u> (ft)		
H. Measure performance:		

Laptop Base Station

Speed:	11 Mbps	100%	100%
5.5 Mbps	0	0	
2.0 Mbps	0	0	
1.0 Mbps	0	0	
SNR	56	50	
Power	-40	-48	
Noise	-94	-97	

Comments: No problems in configuring base station. Readings were taken on 3/6/03 in lab.

3.2 TEST 2: INITIALIZE EDL-LAB2**OBJECTIVE:** Repeat Test 1 for the second Microsoft Base Station

Test	2		
Date:	2/17/03 & 3/7/03	Time:	1400 & 0900
Location:	EDL Rm 240		
Test Coordinator:	W. G. Harris		
Test Personnel:	Dave Miller		
Hardware (LT/BS)	#BH	EDL-lab2	
Address	00-02-2D-6E-A2-F4	00-50-F2-C7-C5-6C	
Height:	3-ft	5-ft	
Encryption (WEP):	128 bit	Firewall:	On
Test Equipment:	Laptop #BH	Cal:	none

Set-up and Checkout of EDL-lab2

	<u>Pass</u>	<u>Fail</u>
Using instructions in Reference [4], perform the following test:		
I. Load software on to a laptop. Successful?	<u>X</u>	_____
J. Power up and configure the base station. Successful?	<u>X</u>	_____
K. Connect base station to LAN through lab router. Successful?	<u>X</u>	_____
L. Disconnect laptop cable to base station, and reconnect with wireless link. Successful?	<u>X</u>	_____
M. Time to acquire link? <u>10 sec</u> sec.		
N. Connect to WWW through wireless link. Successful?	<u>X</u>	_____
O. Measure distance, laptop to base station <u>5</u> (ft)		
P. Measure performance:		

	<u>Laptop</u>	<u>Base Station</u>	
Speed:	11 Mbps	100%	100%
5.5 Mbps	0	0	
2.0 Mbps	0	0	
1.0 Mbps	0	0	
SNR	52	58	
Power	-40	-46	
Noise	-93	-102	

Comments:

No problems in configuring base station. Readings taken 3/7/03 in Rm 240.

3.3 TEST 3: BASELINE PERFORMANCE DISTRIBUTION (25 FT)

OBJECTIVE: Test the baseline performance distribution of a Microsoft Wireless base Station MN-500 (EDL-lab1) from a laptop located 25 feet away.

Test	3		
Date:	3/27/03	Time:	900
Location:	EDL Advanced Network Development Lab		
Test Coordinator:	W. G. Harris		
Test Personnel:			
Hardware (LT/BS)	#BH	EDL-lab1	
Address	00-02-2D-6E-A2-F4	00-50-F2-C7-21-6C	
Height:	10 inches	10 inches	
Encryption (WEP):	128 bit	Firewall:	On
Test Equipment:	Laptop #BH built-in software	Cal:	new

General Procedures

- Confirm the WEP, firewall and pings are set as shown above
- Place Microsoft Base Station (EDL-lab1) 10 inches above floor
- Place the Gateway laptop (#BH) 10 inches above floor and 25 ft horizontally
- Confirm & record partner IP: 00-50-F2-C7-21-6C
- Record the data shown at 30 second intervals for 4.5 minutes
- Configure Test set-up as shown in Figure 3-1.

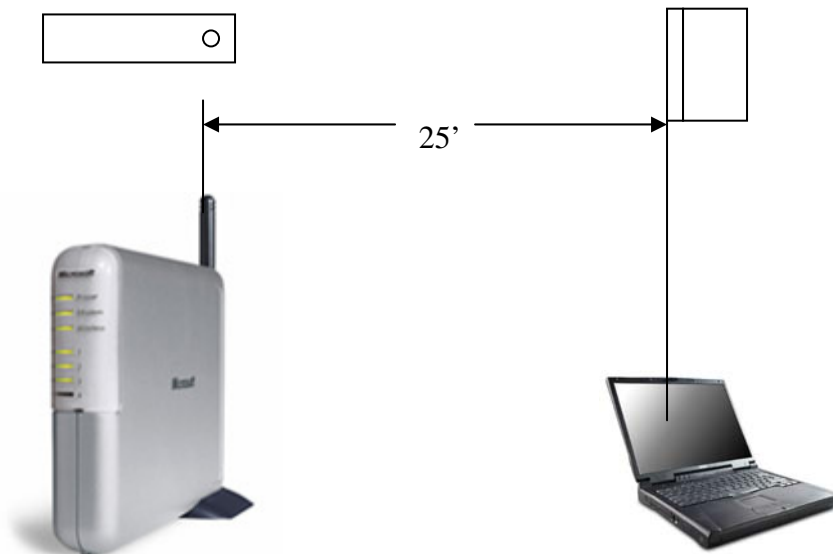


Figure 3-1
25-Ft Baseline Test Set-up

Table 3-1 –Baseline Performance Distribution (25 Ft)

		Laptop							Base station			Comments
Test	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	
Run	Sec	11	5.5	2	1		dB	dB		dB	dB	
3.1	0	100	0	0	0	43	-50	-93	43	-56	-100	
3.2	30	100	0	0	0	46	-50	-95	45	-54	-99	
3.3	60	100	0	0	0	49	-51	-99	43	-56	-99	
3.4	90	100	0	0	0	42	-50	-91	44	-56	-102	
3.5	120	100	0	0	0	49	-49	-98	44	-55	-102	
3.6	150	100	0	0	0	46	-52	-97	44	-56	-100	
3.7	180	100	0	0	0	38	-54	-92	42	-57	-100	
3.8	210	100	0	0	0	40	-52	-93	44	-56	-100	
3.9	240	100	0	0	0	43	-54	-96	43	-57	-100	
3.10	270	100	0	0	0	38	-55	-92	42	-57	-100	
Avg	0	100	0	0	0	43.4	-51.7	-94.6	43.4	-56	-100.2	
Media n	120	100	0	0	0	43.0	-51.5	-94.0	43.5	-56.0	-100.0	
Std Dev	130	45	55	0	0	4.1	2.1	2.8	1.0	0.9	1.0	
Mode	140	90	10	0	0	43	-50.0	-93.0	44.0	-56.0	-100.0	

3.4 TEST 4: WI-FI PERFORMANCE WITH ANTENNA POSITION

OBJECTIVE: Test the performance of Microsoft Wireless base Station MN-500 (EDL-lab1) with a laptop receiver at 25 feet while the antenna position is varied from –180 degrees to +180 degrees.

Test	4		
Date:		Time:	1300
Location:	EDL Advanced Network Development Lab (ANDL)		
Test Coordinator:	W. G. Harris		
Test Personnel:			
Hardware (LT/BS)	#BH	EDL-lab1	
Address	00-02-2D-6E-A2-F4	00-50-F2-C7-21-6C	
Height:	1.5-ft	1.5-ft	
Encryption (WEP):	128 bit	Firewall:	On
Test Equipment:	Laptop #BH built-in software	Cal:	new

General Procedures

- Confirm the WEP, firewall and pings are set as shown above
- Place Microsoft Base Station (EDL-lab1) on a platform in the ANDL
- Place the Gateway laptop (#BH) at 25-ft from Base Station
- Confirm & record partner IP: 00-50-F2-C7-21-6C
- Record the data shown while varying the antenna position as indicated
- Configure Test set-up as shown in Figure 3-2.



Figure 3-2
Antenna Position Test Set-Up

Test 4 Data Requirements

Recorded Test Data

- Data Rate (Percent at following)
 - 11 Mbps
 - 5.5 Mbps
 - 2 Mbps
 - 1 Mbps
- Laptop
 - SNR
 - Signal (dB)
 - Noise (dB)
- Base Station
 - SNR
 - Signal (dB)
 - Noise (dB)

Specific Test Parameters

- Record the Test Data above every 30 seconds for a total of 3 minutes.
- Record Test Data at each of the antenna positions in Table 3-2

Table 3-2 Antenna Test Positions

Rotation Deg	Clock Position	Antenna Position
0	12:00	Rear
+45	10:30	Rear
+90	9:00	Rear
+135	7:30	Rear
+180	6:00	Rear
-180	6:00	Front
-135	4:30	Front
-90	3:00	Front
-45	1:30	Front
0	12:00	Front

3.5 TEST 5: WI-FI PERFORMANCE WITH DISTANCE (EDL-LAB1)

OBJECTIVE: Test performance of both Base Stations as the distance from the Base Station and Laptop is varied out to 300 ft. Test may be done independently.

Test	5		
Date:		Time:	
Location:	EDL first floor hall & East parking lot		
Test Coordinator:	W. G. Harris		
Test Personnel:			
Hardware (LT/BS)	#BH	EDL-lab1 & EDL-lab2	
Address	00-02-2D-6E-A2-F4	00-50-F2-C7-21-6C (lab1)	
		00-50-F2-C7-C5-6C (lab2)	
Height:	3-ft	5-ft	
Encryption (WEP):	128 bit	Firewall:	On
Test Equipment:	Laptop #BH	Cal:	none

General Procedures

- Confirm the WEP, firewall and pings are set as shown above
- Place Microsoft Base Station in the downstairs hallway of the EDL on a raised platform
- Place the Gateway laptop (#BH) at the distances shown
- Confirm & record partner IP
- Configure Test set-up as shown in Figure 3-3.

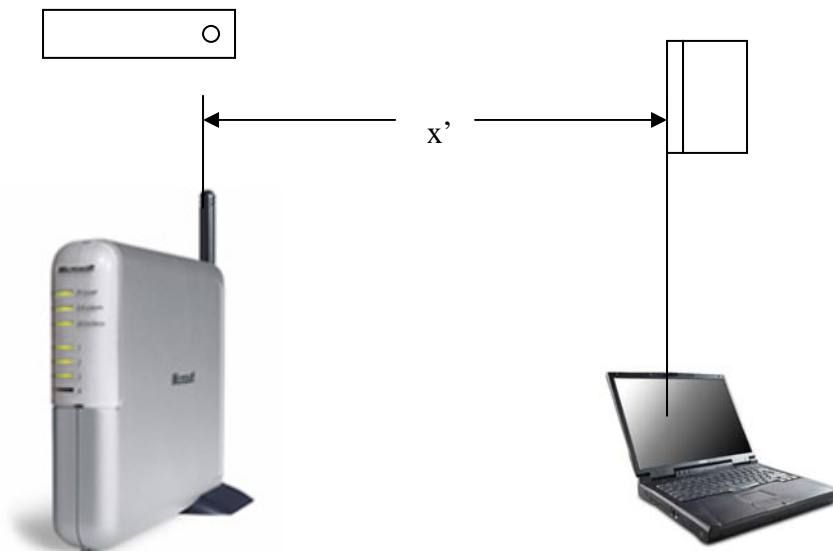


Figure 3-3 Distance Performance Test Set-Up

Test 5 Data Requirements

Recorded Test Data

- Data Rate (Percent at following)
 - 11 Mbps
 - 5.5 Mbps
 - 2 Mbps
 - 1 Mbps
- Laptop
 - SNR
 - Signal (dB)
 - Noise (dB)
- Base Station
 - SNR
 - Signal (dB)
 - Noise (dB)

Specific Test Parameters

- Record the Test Data above every 30 seconds for total of 3 minutes
- Take measurements at each 10-ft location out to 300 feet
- Repeat test for EDL-lab2

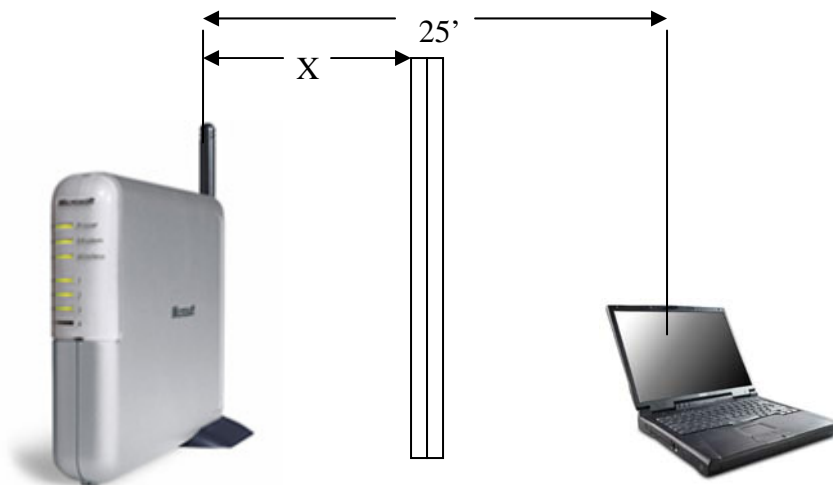
3.6 TEST 6: PERFORMANCE WITH ATTENUATION (EDL-LAB1)

OBJECTIVE: Test the performance of the Microsoft Base Station (EDL-lab1) with various attenuation barriers between the access point and the laptop receiver.

Test	6		
Date:	Time:		
Location:	EDL Advanced Network Development Lab, Rm 124		
Test Coordinator:	W. G. Harris		
Test Personnel:			
Hardware (LT/BS)	#BH	EDL-lab1	
Address	00-02-2D-6E-A2-F4	00-50-F2-C7-21-6C	
Height:			
Encryption (WEP):	128 bit	Firewall:	On
Test Equipment:	Laptop #BH	Cal:	none
Attenuation:			

General Procedures

- Confirm the WEP, firewall and pings are set as shown above
- Place Microsoft Base Station (EDL-lab1) on a platform in the ANDL
- Place the Gateway laptop (#BH) at 25-ft from Base Station
- Confirm & record partner IP: 00-50-F2-C7-21-6C
- Record the data shown while varying the barrier position as indicated
- Configure Test set-up as shown in Figure 3-4.



Attenuation Barrier

Figure 3-4 Attenuation Test Set-up

Test 6 Data Requirements

Recorded Test Data

- Data Rate (Percent at following)
 - 11 Mbps
 - 5.5 Mbps
 - 2 Mbps
 - 1 Mbps
- Laptop
 - SNR
 - Signal (dB)
 - Noise (dB)
- Base Station
 - SNR
 - Signal (dB)
 - Noise (dB)

Specific Test Parameters

- Record the Test Data above every 30 seconds for total of 3 minutes
- Record baseline data first with no barrier present
- Take measurements at each of following distances from Base Station
 - (2, 5, 10, 15, 20, 23 ft)
- Repeat test for each barrier configuration in Table 3-4

Table 3-4 Attenuation Barriers

Wall	Description	Quan	Height	Width	Thk
			in.	in.	in.
1	Baseline	0	0	0	0
2	Wall partitions, canvas covered particle board core	1	54	62	1.88
3	Wall partitions, canvas covered particle board core	2	54	62	3.76
4	Aluminium sheet	1	40	40	.125
5	Aluminium sheet	1	36	30.5	.187
6	Steel sheet	1	75.5	37	.063
7	Cinder blocks	3	24	16	8
8	Cinder blocks	6	24	16	16
9	Cinder blocks	6	24	32	8
10	Human	1	6'2"	215 lbs	

3.7 TEST 7: WI-FI PERFORMANCE WITH INTERFERENCE (EDL-LAB1)

OBJECTIVE: This series of tests will measure the performance of the Microsoft Base Station (EDL-lab1) in the presence of various electrical systems that could possibly cause interference. Any interference on the foreign system is to be also noted and measurements recorded.

Test	7		
Date:	Time:		
Location:	EDL Advanced Network Development Lab, Rm 124 & remote locations		
Test Coordinator:	W. G. Harris		
Test Personnel:			
Hardware (LT/BS)	#BH	EDL-lab1	
Address	00-02-2D-6E-A2-F4	00-50-F2-C7-21-6C	
Height:			
Encryption (WEP):	128 bit	Firewall:	On
Test Equipment:	Laptop #BH	Cal:	none
Interference:			

General Procedures

- Confirm the WEP, firewall and pings are set as shown above
- Place Microsoft Base Station (EDL-lab1) on a platform in the test location
- Place the Gateway laptop (#BH) at 25-ft from Base Station
- Confirm & record partner IP: 00-50-F2-C7-21-6C
- Record the data shown while varying the interference system as indicated
- Configure Test set-up as shown in Figure 3-5.

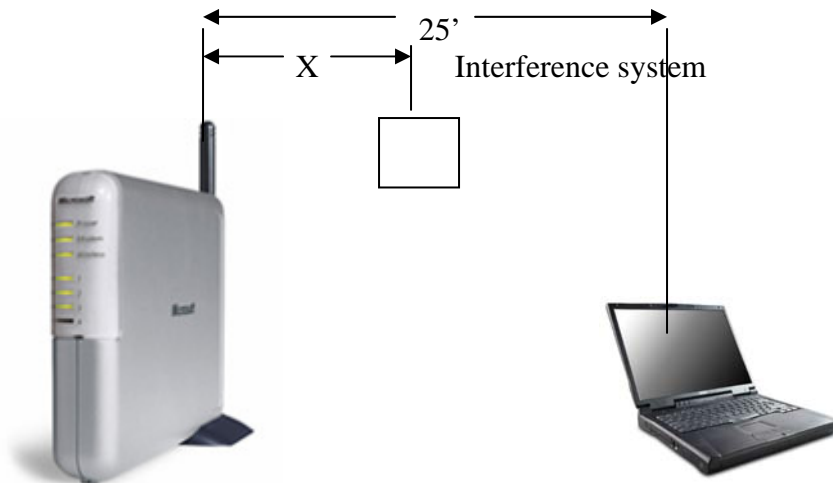


Figure 3-5 Interference Test Set-up

Test 6 Data Requirements

Recorded Test Data

- Data Rate (Percent at following)
 - 11 Mbps
 - 5.5 Mbps
 - 2 Mbps
 - 1 Mbps
- Laptop
 - SNR
 - Signal (dB)
 - Noise (dB)
- Base Station
 - SNR
 - Signal (dB)
 - Noise (dB)

Specific Test Parameters

- Record the Test Data above every 30 seconds for total of 3 minutes
- Record baseline data first with no interference present
- Take measurements with the interference system at each of following distances from Base Station
 - (2, 5, 10, 15, 20, 23 ft)
- Record any varying Interference System parameters
- Repeat test for each Interference System in Table 3-5

Table 6a – Interference Sources

Item	Description
1	Ultra Wide Band Transceiver
2	Microwave oven
3	2.5 GHz Cordless Phone
4	Cell Phone
5	Aircraft Nav Radio
6	Aircraft Comm Radio
7	GPS Receiver
8	Iridium phone, transmitting, 5-ft from Base Station (If possible)

4.0 GLOSSARY

The following acronyms and abbreviations are used in this document:

ANDL	Advanced Network Development Lab (EDL Rm. 124)
ASRC	Artic Slope Regional Corporation
CCAFS	Cape Canaveral Air Force Station
COTS	Commercial Off The Shelf
ECT	Emerging Communication Technology
EDL	Engineering Development Laboratory
FY	Fiscal Year (Oct-Sept)
IEEE	Institute of Electrical & Electronic Engineers
KSC	Kennedy Space Center
LAN	Local Area Network
MAC	Media Access Controller (Machine address)
Mbps	Million Bits Per Second
SNR	Signal to Noise Ratio
TRR	Test Readiness Review
USTDC	University-Affiliated Spaceport Technology Development Contract
W	Watts
WEP	Encryption code key (26 characters = 128 bit encryption)
Wi-Fi	Wireless Ethernet
WWW	World Wide Web

APPENDIX C WI-FI TEST RESULTS**Wi-Fi Test Summary**

St	Test-TAB	Date	Description
c	1		Initialize EDL-lab1
c	2		Initialize EDL-lab2
c	3	3/27/03	EDL-lab1 Baseline @ 25 Ft
c	4.0	4/8/03	Summary - Wi-Fi Performance with Antenna Position
c	4.1	3/28/03	Wi-Fi Performance with Antenna Position: Back-12:00
c	4.2	3/28/03	Wi-Fi Performance with Antenna Position: Back-10:30
c	4.3	3/28/03	Wi-Fi Performance with Antenna Position: Back-9:00
c	4.4	3/28/03	Wi-Fi Performance with Antenna Position: Back-7:30
c	4.5	3/28/03	Wi-Fi Performance with Antenna Position: Back-6:00
c	4.6	3/28/03	Wi-Fi Performance with Antenna Position: Front-6:00
c	4.7	3/28/03	Wi-Fi Performance with Antenna Position: Front-4:30
c	4.8	3/28/03	Wi-Fi Performance with Antenna Position: Front-3:00
c	4.9	3/28/03	Wi-Fi Performance with Antenna Position: Front-1:30
c	4.10	3/28/03	Wi-Fi Performance with Antenna Position: Front-12:00
c	5.1	4/2/03	Wi-Fi Performance with Distance (EDL-lab1)
c	5.2	4/17/03	Wi-Fi Performance with Distance (EDL-lab2)
c	5.3	4/17/03	Wi-Fi Performance with Two Base Stations (EDL-lab1 & EDL-lab2)
c	6.1	4/11/03	Wi-Fi Performance with One Partition
c	6.2	4/11/03	Wi-Fi Performance with Two Partitions
c	6.3	4/8/03	Wi-Fi Performance with .125 Al Sheet
c	6.4	4/8/03	Wi-Fi Performance with .187 Al Sheet
c	6.5	4/8/03	Wi-Fi Performance with .063 Steel Sheet
c	6.6	4/17/03	Wi-Fi Performance with Cinder Blocks (3 h, 1 w, 1 t)
c	6.7	4/17/03	Wi-Fi Performance with Cinder Blocks (3 h, 1 w, 2 t)
c	6.8	4/17/03	Wi-Fi Performance with Cinder Blocks (3 h, 2 w, 1 t)
c	6.9	4/15/03	Wi-Fi Performance with Human Barrier
c	7.1	4/15/03	Wi-Fi Performance Adjacent To UWB
c	7.1x	3/27/03	Wi-Fi Performance Adjacent To UWB (2 distances)
c	7.2	7/20/03	Wi-Fi Performance Adjacent To Microwave Oven
c	7.3	7/20/03	Wi-Fi Performance Adjacent To 2.4 GHz Cordless Phone
c	7.4	4/15/03	Wi-Fi Performance Adjacent To Cell Phone
c	7.5	7/8/03	Wi-Fi Performance Adjacent To Aircraft Nav Radio
c	7.6	7/10/03	Wi-Fi Performance Adjacent To Aircraft Com Radio
c	7.7	7/14/03	Wi-Fi Performance Adjacent To GPS Receiver
c	7.8	4/15/03	Wi-Fi Performance Adjacent To Iridium Phone
c	8.0	8/28/03	Wi-Fi Performance With 802.11b And 802.11g

1.0 **TEST 1: SET-UP, FUNCTION & INTEROPERABILITY (EDL-LAB1)**

OBJECTIVE: Test the set-up procedures, functionality, and interoperability for the Microsoft Wireless base Station MN-500 and the Wi-Fi hardware/software built-in to the Gateway laptop.

Test	1		
Date:	2/17/03 & 3/6/03	Time:	0900 & 1300
Location:	EDL Advanced Network Development Lab, Rm 124		
Test Coordinator:	W. G. Harris		
Test Personnel:	Dave Miller		
Hardware (LT/BS)	#BH	EDL-lab1	
Address	00-02-2D-6E-A2-F4	00-50-F2-C7-21-6C	
Height:	3-ft	5-ft	
Encryption (WEP):	128 bit	Firewall:	On
Test Equipment:	Laptop #BH	Cal:	none

Table 1 – Set-up and Checkout of EDL-lab1

	<u>Pass</u>	<u>Fail</u>
Using instructions in Reference [4], perform the following test:		
Q. Load software on to a laptop. Successful?	<u>X</u>	_____
R. Power up and configure the base station. Successful?	<u>X</u>	_____
S. Connect base station to LAN through lab router. Successful?	<u>X</u>	_____
T. Disconnect laptop cable to base station, and reconnect with wireless link. Successful?	<u>X</u>	_____
U. Time to acquire link? <u>10 sec</u> sec.		
V. Connect to WWW through wireless link. Successful?	<u>X</u>	_____
W. Measure distance, laptop to base station <u>5</u> (ft)		
X. Measure performance:		
	<u>Laptop</u>	<u>Base Station</u>
Speed: 11 Mbps	100%	100%
5.5 Mbps	0	0
2.0 Mbps	0	0
1.0 Mbps	0	0
SNR	56	50
Power	-40	-48
Noise	-94	-97

Comments: No problems in configuring base station. Readings were taken on 3/6/03 in lab.

2.0 TEST 2: SET-UP, FUNCTION & INTEROPERABILITY (EDL-LAB2)

OBJECTIVE: Repeat Test 1 for second Microsoft Base Station

Test	2		
Date:	2/17/03 & 3/7/03	Time:	1400 & 0900
Location:	EDL Rm 240		
Test Coordinator:	W. G. Harris		
Test Personnel:	Dave Miller		
Hardware (LT/BS)	#BH	EDL-lab2	
Address	00-02-2D-6E-A2-F4	00-50-F2-C7-C5-6C	
Height:	3-ft	5-ft	
Encryption (WEP):	128 bit	Firewall:	On
Test Equipment:	Laptop #BH	Cal:	none

Table 2 – Set-up and Checkout of EDL-lab2

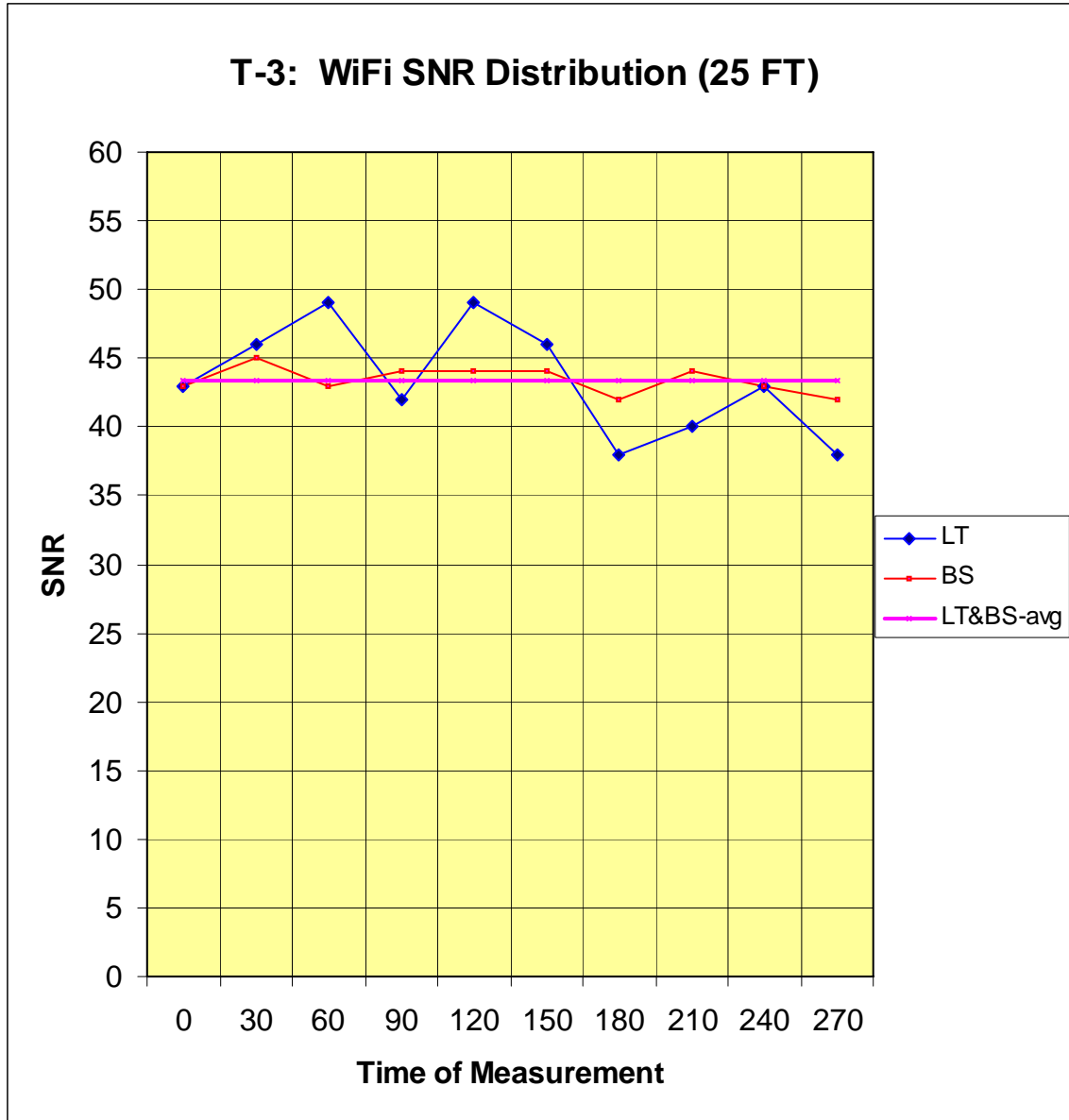
	<u>Pass</u>	<u>Fail</u>
Using instructions in Reference [4], perform the following test:		
Y. Load software on to a laptop. Successful?	<u>X</u>	_____
Z. Power up and configure the base station. Successful?	<u>X</u>	_____
AA. Connect base station to LAN through lab router. Successful?	<u>X</u>	_____
BB. Disconnect laptop cable to base station, and reconnect with wireless link. Successful?	<u>X</u>	_____
CC. Time to acquire link? <u>10 sec</u> sec.		
DD. Connect to WWW through wireless link. Successful?	<u>X</u>	_____
EE. Measure distance, laptop to base station <u>5</u> (ft)		
FF. Measure performance:		
	<u>Laptop</u>	<u>Base Station</u>
Speed: 11 Mbps	100%	100%
5.5 Mbps	0	0
2.0 Mbps	0	0
2.0 Mbps	0	0
SNR	52	58
Power	-40	-46
Noise	-93	-102
Comments:		

No problems in configuring base station. Readings taken 3/7/03 in Rm 240.

3.0

TEST 3: BASELINE PERFORMANCE AT 25 FT**WiFi Baseline Performance Distribution (25 Ft)**

Test	3														
Date	3/27/03					Time	900								
Location						EDL Advanced Network Development Lab									
Test Coordinator:						W. Harris									
Test Personnel:															
Hardware:						Laptop	#BH			Base station:	EDL-lab1				
Address:						00-02-2D-6E-A2-F4					00-50-F2-C7-21-6C				
Encryption (WEP):						128 bit				Firewall:	on	Pings:	Open		
Test Equipment:						Laptop built-in measuring software									
Antenna						Vertical						Cal:	new		
Distance:						25 ft									
						Laptop						Base station			Comments
Test	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	LT	BS		
Run	sec	11	5.5	2	1		dB	dB		dB	dB	Avg	Avg		
3.1	0	100	0	0	0	43	-50	-93	43	-56	-100	43.4	43.4		
3.2	30	100	0	0	0	46	-50	-95	45	-54	-99	43.4	43.4		
3.3	60	100	0	0	0	49	-51	-99	43	-56	-99	43.4	43.4		
3.4	90	100	0	0	0	42	-50	-91	44	-56	-102	43.4	43.4		
3.5	120	100	0	0	0	49	-49	-98	44	-55	-102	43.4	43.4		
3.6	150	100	0	0	0	46	-52	-97	44	-56	-100	43.4	43.4		
3.7	180	100	0	0	0	38	-54	-92	42	-57	-100	43.4	43.4		
3.8	210	100	0	0	0	40	-52	-93	44	-56	-100	43.4	43.4		
3.9	240	100	0	0	0	43	-54	-96	43	-57	-100	43.4	43.4		
3.10	270	100	0	0	0	38	-55	-92	42	-57	-100	43.4	43.4		
Avg						43.4	-51.7	-94.6	43.4	-56	-100.2				
Median						43.0	-51.5	-94.0	43.5	-56.0	-100.0				
Std Dev						4.1	2.1	2.8	1.0	0.9	1.0				
Mode						43.0	-50.0	-93.0	44.0	-56.0	-100.0				

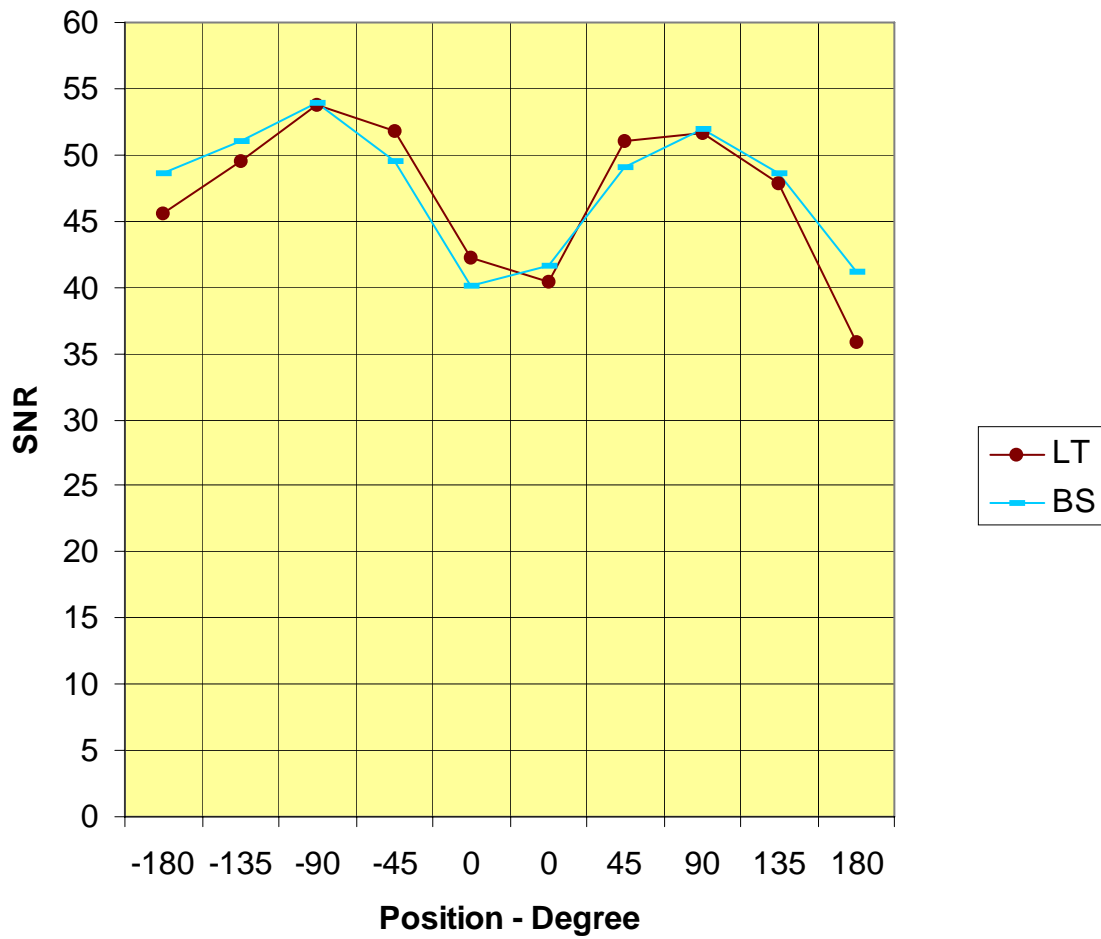


4.0

TEST 4: WI-FI PERF. VS ANTENNA POSITION (SUMMARY)

Summary - WiFi Performance Vs Antenna Position

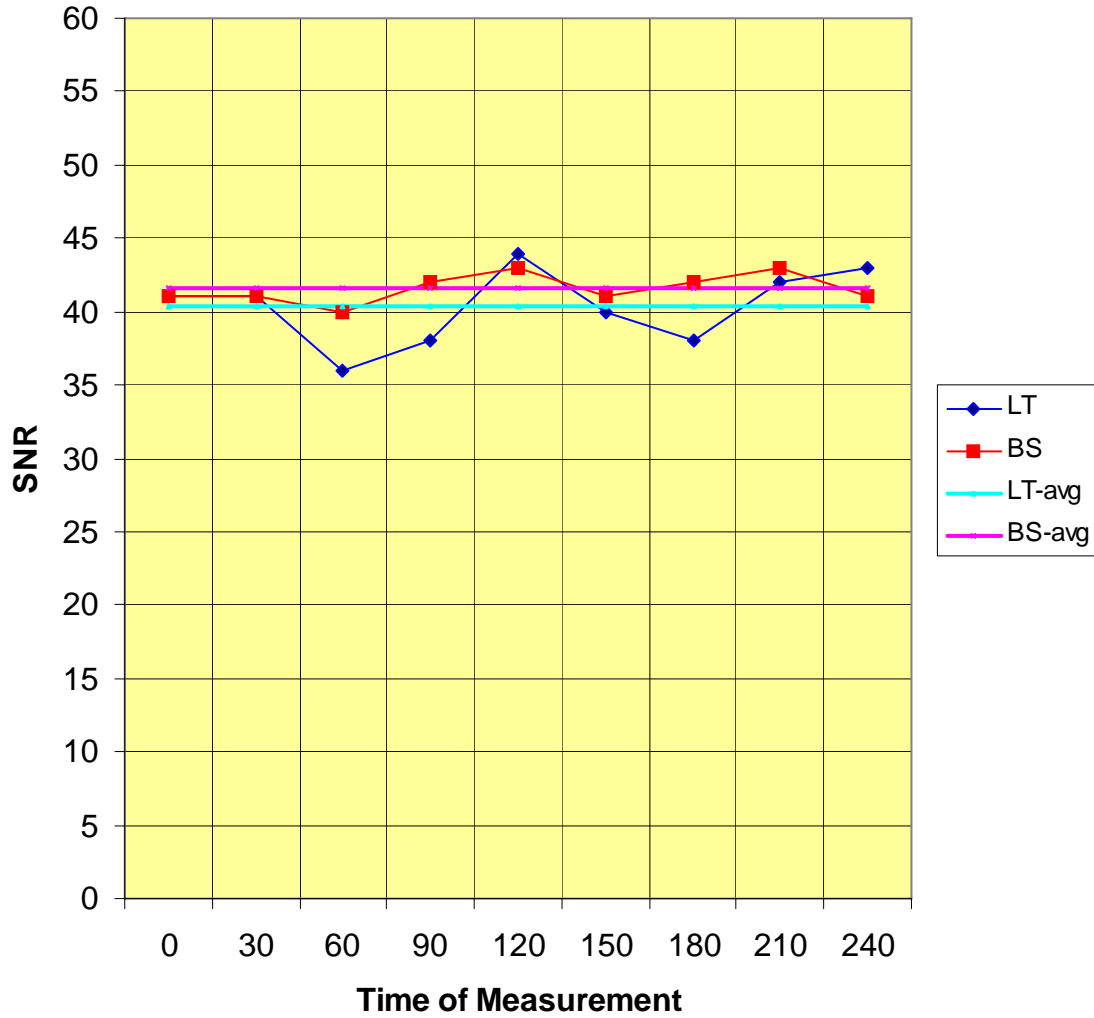
Test	4.0												
Date	4/8/03			Time	NA								
Location				EDL Advanced Network Development Lab									
Test Coordinator:				W. Harris									
Test Personnel:													
Hardware:				Laptop	#BH		Base station:		EDL-lab1				
Address:				00-02-2D-6E-A2-F4			00-50-F2-C7-21-6C						
Encryption (WEP):				128 bit			Firewall:		on	Pings:	Open		
Test Equipment:				Laptop built-in measuring software						Cal:	new		
Antenna:				Varing									
Distance:				25 ft									
			Laptop							Base station			Comments
Test	Ant angl	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise		
Run	Deg	11	5.5	2	1		dB	dB		dB	dB		
4.6	-180	100	0	0	0	45.6	-49.3	-93.9	48.6	-53.6	-101.0		
4.7	-135	100	0	0	0	49.4	-44.3	-94.2	51.0	-50.6	-101.0		
4.8	-90	100	0	0	0	53.8	-40.4	-94.4	53.9	-48.1	-101.0		
4.9	-45	100	0	0	0	51.8	-42.6	-94.2	49.4	-50.4	-100.0		
4.10	0	100	0	0	0	42.2	-52.4	-94.4	40.1	-58.2	-100.0		
4.1	0	100	0	0	0	40.3	-53.2	-93.7	41.6	-57.7	-100.0		
4.2	45	100	0	0	0	51.0	-44.0	-94.2	49.0	-51.8	-99.6		
4.3	90	100	0	0	0	51.7	-42.1	-93.2	52.0	-49.8	-101.0		
4.4	135	100	0	0	0	47.9	-46.4	-94.2	48.6	-53.1	-101.0		
4.5	180	100	0	0	0	35.8	-59.0	-94.8	41.1	-60.3	-101.0		
Avg						48.6	-45.8	-94.2	48.6	-52.2	-100.6		
Median						49.4	-44.3	-94.2	49.4	-50.6	-101.0		
Std Dev						4.7	4.9	0.2	5.2	3.9	0.5		
Mode						#N/A	#N/A	-94.2	#N/A	#N/A	-101.0		

T-4.0: Summary - WiFi SNR Vs Antenna Position

4.1 TEST 4.1: ANTENNA REAR, 12:00

WiFi Performance with Antenna Position: Rear-12

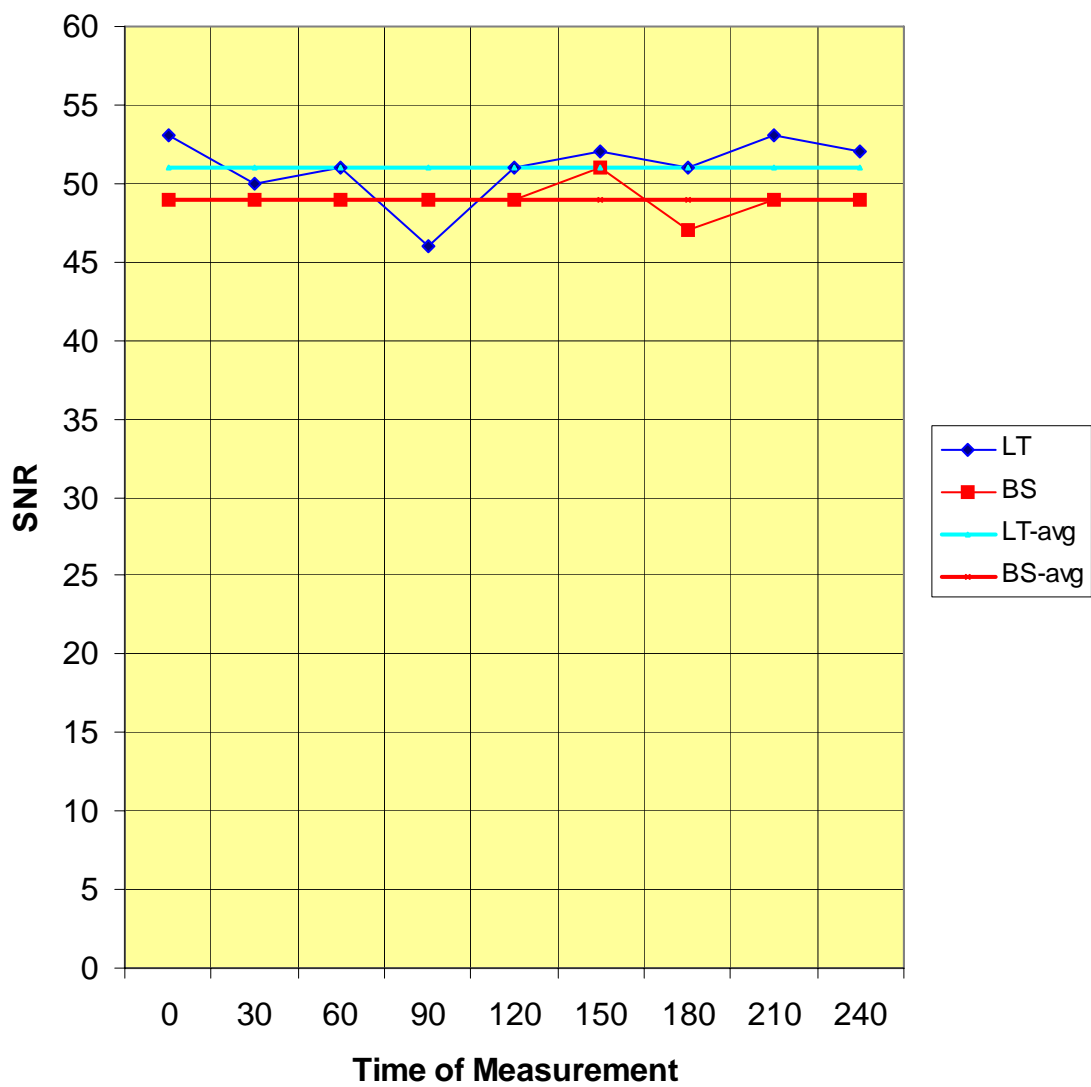
Test	4.1													
Date	3/28/03				Time	11:45								
Location					EDL Advanced Network Development Lab									
Test Coordinator:					W. Harris									
Test Personnel:														
Hardware:					Laptop	#BH			Base station:	EDL-lab1				
Address:					00-02-2D-6E-A2-F4					00-50-F2-C7-21-6C				
Encryption (WEP):					128 bit				Firewall:	on	Pings:	Open		
Test Equipment:					Laptop built-in measuring software					Cal:	new			
Antenna:					Rear-12:00 (Vertical)									
Distance:					25 ft									
					Laptop						Base station			
Test	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	LT	BS	Comments
Run	sec	11	5.5	2	1		dB	dB		dB	dB	Avg SNR	Avg SNR	
4.1.1	0	100	0	0	0	41	-54	-94	41	-58	-100	40.3	41.6	
4.1.2	30	100	0	0	0	41	-54	-95	41	-58	-100	40.3	41.6	
4.1.3	60	100	0	0	0	36	-55	-92	40	-59	-100	40.3	41.6	
4.1.4	90	100	0	0	0	38	-54	-92	42	-58	-100	40.3	41.6	
4.1.5	120	100	0	0	0	44	-52	-95	43	-56	-100	40.3	41.6	
4.1.6	150	100	0	0	0	40	-53	-94	41	-58	-100	40.3	41.6	
4.1.7	180	100	0	0	0	38	-53	-91	42	-57	-100	40.3	41.6	
4.1.8	210	100	0	0	0	42	-52	-94	43	-57	-100	40.3	41.6	
4.1.9	240	100	0	0	0	43	-52	-96	41	-58	-100	40.3	41.6	
Avg						40.3	-53.2	-93.7	41.6	-57.7	-100.0			
Median						41.0	-53.0	-94.0	41.0	-58.0	-100.0			
Std Dev						2.6	1.1	1.7	1.0	0.9	0.0			
Mode						41.0	-54.0	-94.0	41.0	-58.0	-100.0			

T-4.1: WiFi SNR with Ant. Position: Rear-12:00

4.2 TEST 4.2: ANTENNA REAR, 10:30

WiFi Performance with Antenna Position: Rear-10:30

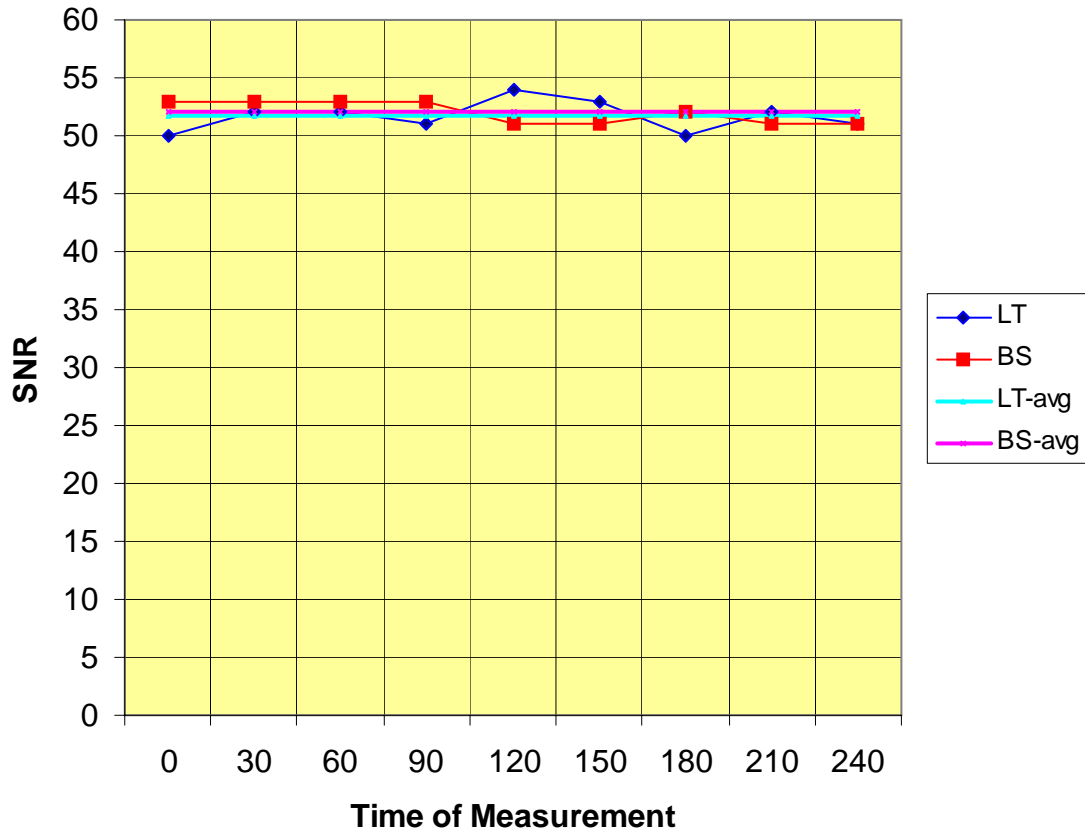
Test	4.2													
Date	3/28/03					Time	11:55							
Location						EDL Advanced Network Development Lab								
Test Coordinator:						W. Harris								
Test Personnel:														
Hardware:						Laptop	#BH		Base station:	EDL-lab1				
Address:						00-02-2D-6E-A2-F4			00-50-F2-C7-21-6C					
Encryption (WEP):						128 bit			Firewall:	on	Pings:	Open		
Test Equipment:						Laptop built-in measuring software					Cal:	new		
Antenna:						Rear-10:30 (45-deg CCW)								
Distance:						25 ft								
						Laptop						LT	BS	Comments
Test	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	Avg	Avg	
Run	sec	11	5.5	2	1		dB	dB		dB	dB	SNR	SNR	
4.2.1	0	100	0	0	0	53	-44	-95	49	-52	-99	51.0	49.0	
4.2.2	30	100	0	0	0	50	-44	-93	49	-52	-99	51.0	49.0	
4.2.3	60	100	0	0	0	51	-44	-95	49	-52	-100	51.0	49.0	
4.2.4	90	100	0	0	0	46	-44	-91	49	-52	-99	51.0	49.0	
4.2.5	120	100	0	0	0	51	-44	-95	49	-52	-99	51.0	49.0	
4.2.6	150	100	0	0	0	52	-44	-94	51	-50	-101	51.0	49.0	
4.2.7	180	100	0	0	0	51	-44	-94	47	-52	-97	51.0	49.0	
4.2.8	210	100	0	0	0	53	-44	-95	49	-52	-101	51.0	49.0	
4.2.9	240	100	0	0	0	52	-44	-96	49	-52	-101	51.0	49.0	
Avg						51.0	-44.0	-94.2	49.0	-51.8	-99.6			
Median						51.0	-44.0	-95.0	49.0	-52.0	-99.0			
Std Dev						2.1	0.0	1.5	1.0	0.7	1.3			
Mode						51.0	-44.0	-95.0	49.0	-52.0	-99.0			

T-4.2: WiFi SNR With Ant. Position: Rear-10:30

4.3 TEST 4.3: ANTENNA REAR, 9:00

WiFi Performance with Antenna Position: Rear-9:00

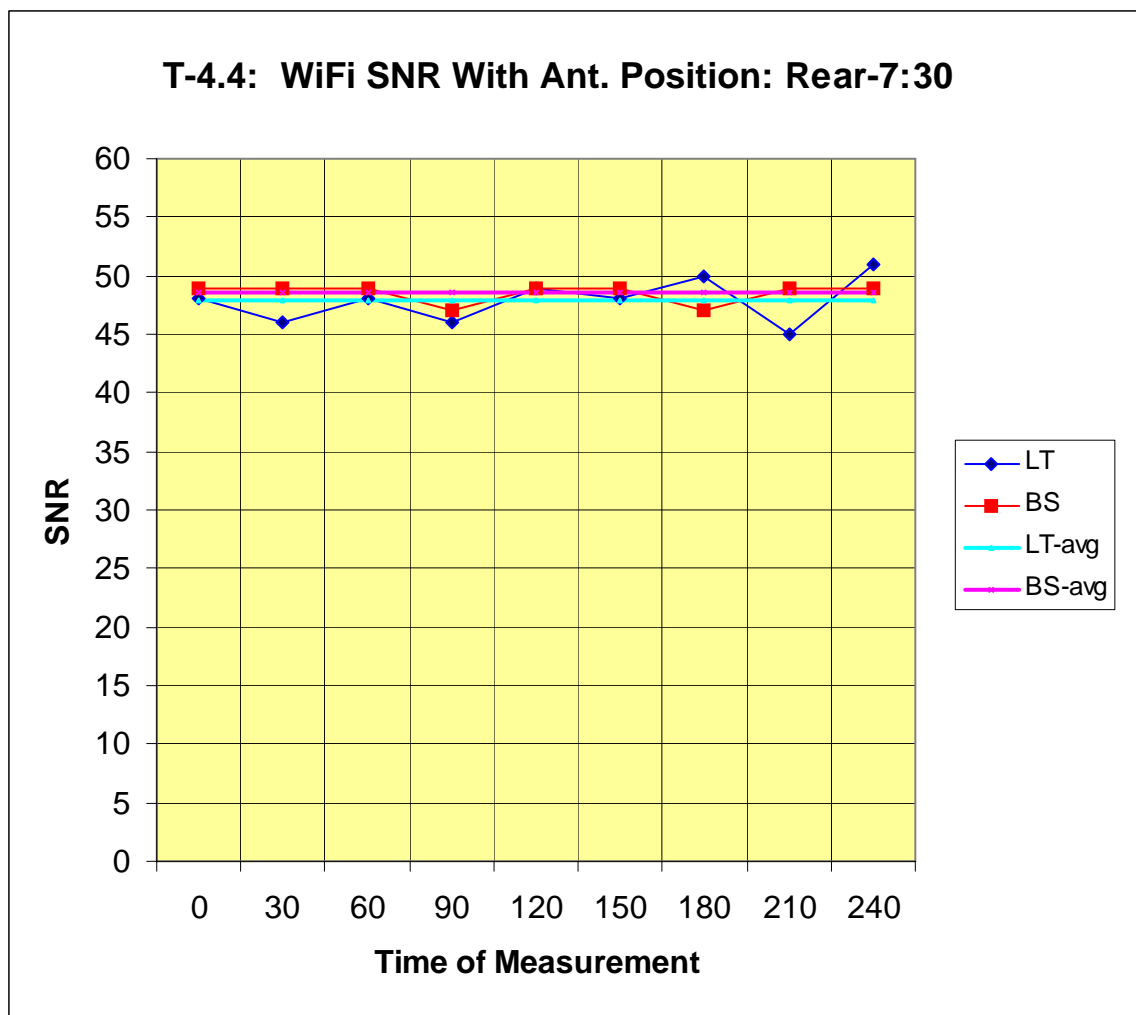
Test	4.3													
Date	3/28/03					Time	12:05							
Location						EDL Advanced Network Development Lab								
Test Coordinator:						W. Harris								
Test Personnel:														
Hardware:						Laptop	#BH			Base station	EDL-lab1			
Address:						00-02-2D-6E-A2-F4				00-50-F2-C7-21-6C				
Encryption (WEP):						128 bit				Firewall:	on	Pings:	Open	
Test Equipment:						Laptop built-in measuring software					Cal:	new		
Antenna:						Rear-9:00 (90-deg CCW)								
Distance:						25 ft								
						Laptop						Base station		
Test	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	LT	BS	Comments
Run	sec	11	5.5	2	1		dB	dB		dB	dB	Avg	Avg	
												SNR	SNR	
4.3.1	0	100	0	0	0	50	-42	-91	53	-50	-101	51.7	52.0	
4.3.2	30	100	0	0	0	52	-42	-93	53	-50	-101	51.7	52.0	
4.3.3	60	100	0	0	0	52	-42	-94	53	-48	-101	51.7	52.0	
4.3.4	90	100	0	0	0	51	-42	-92	53	-49	-101	51.7	52.0	
4.3.5	120	100	0	0	0	54	-42	-95	51	-50	-101	51.7	52.0	
4.3.6	150	100	0	0	0	53	-42	-95	51	-50	-101	51.7	52.0	
4.3.7	180	100	0	0	0	50	-42	-91	52	-50	-101	51.7	52.0	
4.3.8	210	100	0	0	0	52	-42	-95	51	-50	-101	51.7	52.0	
4.3.9	240	100	0	0	0	51	-43	-93	51	-51	-101	51.7	52.0	
Avg						51.7	-42.1	-93.2	52.0	-49.8	-101.0			
Median						52.0	-42.0	-93.0	52.0	-50.0	-101.0			
Std Dev						1.3	0.3	1.6	1.0	0.8	0.0			
Mode						52.0	-42.0	-95.0	53.0	-50.0	-101.0			

T-4.3: WiFi SNR With Ant. Position: Rear-9:00

4.4 TEST 4.4: ANTENNA REAR, 7:30

WiFi Performance with Antenna Position: Rear-7:30

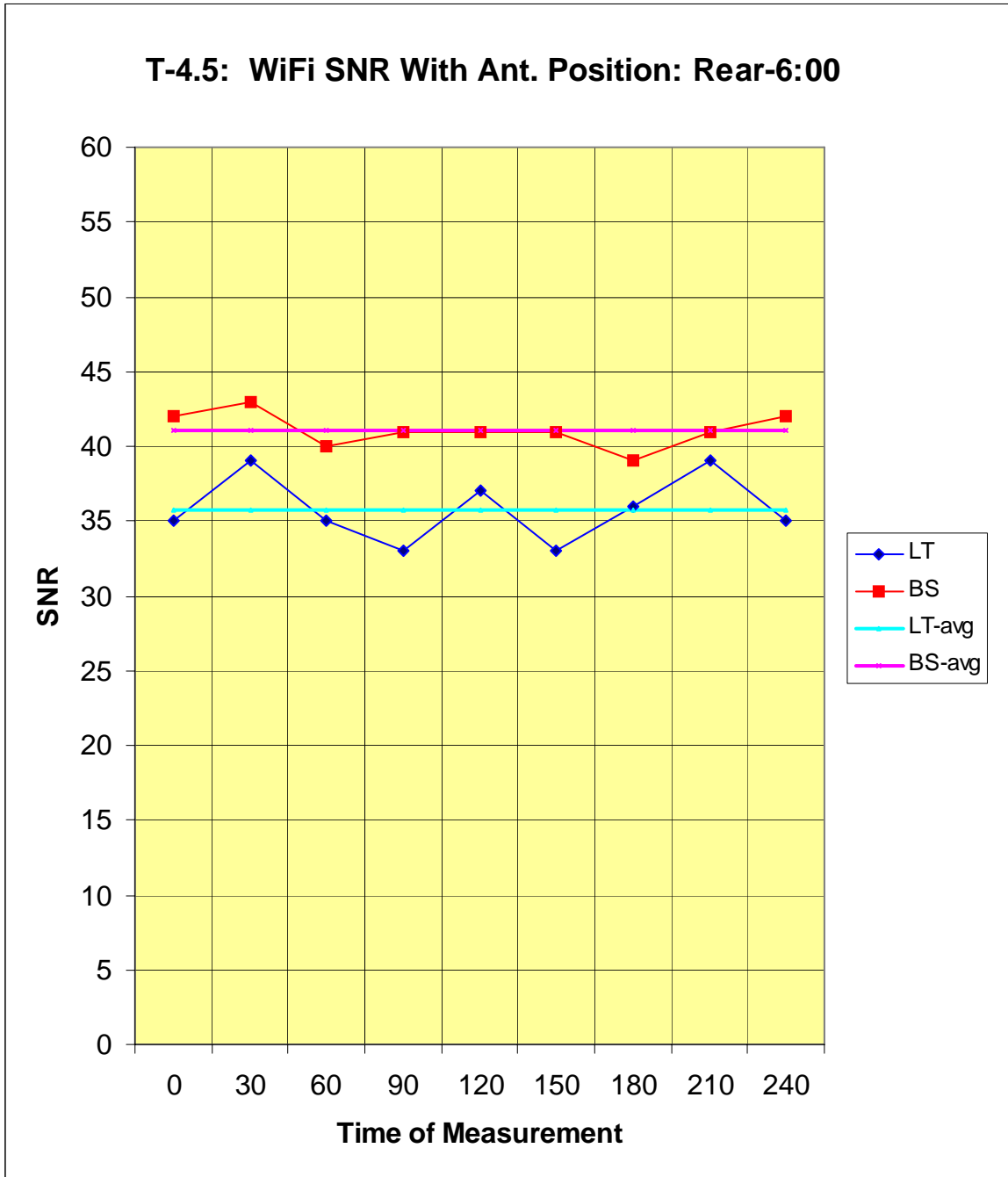
Test	4.4													
Date	3/28/03					Time	12:15							
Location						EDL Advanced Network Development Lab								
Test Coordinator:						W. Harris								
Test Personnel:														
Hardware:						Laptop	#BH			Base station:	EDL-lab1			
Address:						00-02-2D-6E-A2-F4			00-50-F2-C7-21-6C					
Encryption (WEP):						128 bit			Firewall:	on	Pings:	Open		
Test Equipment:						Laptop built-in measuring software					Cal:	new		
Antenna:						Rear-7:30 135-deg CCW)								
Distance:						25 ft								
						Laptop						Base station		
Test	Time	Speed (Mbps)					SNR	Signal	Noise	SNR	Signal	Noise	LT	BS
Run	sec	11	5.5	2	1			dB	dB		dB	dB	SNR	SNR
4.4.1	0	100	0	0	0	48	-46	-94	49	-52	-101	47.9	48.6	
4.4.2	30	100	0	0	0	46	-46	-91	49	-52	-101	47.9	48.6	
4.4.3	60	100	0	0	0	48	-46	-94	49	-54	-101	47.9	48.6	
4.4.4	90	100	0	0	0	46	-47	-93	47	-54	-101	47.9	48.6	
4.4.5	120	100	0	0	0	49	-46	-96	49	-52	-101	47.9	48.6	
4.4.6	150	100	0	0	0	48	-46	-94	49	-52	-101	47.9	48.6	
4.4.7	180	100	0	0	0	50	-47	-95	47	-54	-101	47.9	48.6	
4.4.8	210	100	0	0	0	45	-48	-93	49	-54	-101	47.9	48.6	
4.4.9	240	100	0	0	0	51	-46	-98	49	-54	-101	47.9	48.6	
Avg						47.9	-46.4	-94.2	48.6	-53.1	-101.0			
Median						48.0	-46.0	-94.0	49.0	-54.0	-101.0			
Std Dev						2.0	0.7	2.0	0.9	1.1	0.0			
Mode						48.0	-46.0	-94.0	49.0	-54.0	-101.0			



4.5 TEST 4.5: ANTENNA REAR, 6:00

WiFi Performance with Antenna Position: Rear-6:00

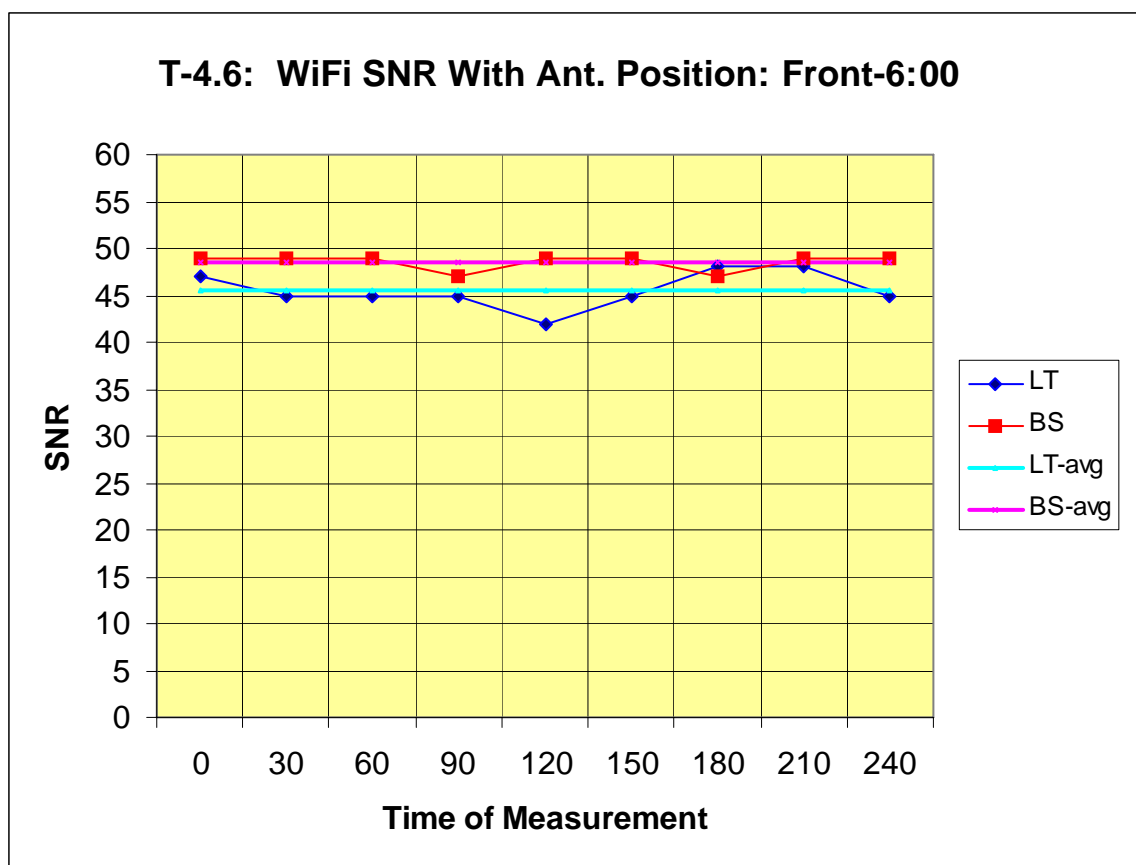
Test	4.5													
Date	3/28/03					Time	12:25							
Location						EDL Advanced Network Development Lab								
Test Coordinator:						W. Harris								
Test Personnel:														
Hardware:						Laptop	#BH			Base station	EDL-lab1			
Address:						00-02-2D-6E-A2-F4			00-50-F2-C7-21-6C					
Encryption (WEP):						128 bit			Firewall:	on	Pings:	Open		
Test Equipment:						Laptop built-in measuring software					Cal:	new		
Antenna:						Rear-6:00 180-deg CCW)								
Distance:						25 ft								
		Laptop						Base station			LT	BS	Comments	
Test	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	Avg	Avg	
Run	sec	11	5.5	2	1		dB	dB		dB	dB	SNR	SNR	
4.5.1	0	100	0	0	0	35	-58	-94	42	-60	-101	35.8	41.1	
4.5.2	30	100	0	0	0	39	-56	-94	43	-59	-101	35.8	41.1	
4.5.3	60	100	0	0	0	35	-61	-96	40	-61	-101	35.8	41.1	
4.5.4	90	100	0	0	0	33	-62	-95	41	-60	-101	35.8	41.1	
4.5.5	120	100	0	0	0	37	-59	-95	41	-60	-101	35.8	41.1	
4.5.6	150	100	0	0	0	33	-60	-93	41	-60	-101	35.8	41.1	
4.5.7	180	100	0	0	0	36	-59	-95	39	-63	-101	35.8	41.1	
4.5.8	210	100	0	0	0	39	-57	-96	41	-60	-101	35.8	41.1	
4.5.9	240	100	0	0	0	35	-59	-95	42	-60	-101	35.8	41.1	
Avg						35.8	-59.0	-94.8	41.1	-60.3	-101.0			
Median						35.0	-59.0	-95.0	41.0	-60.0	-101.0			
Std Dev						2.2	1.9	1.0	1.2	1.1	0.0			
Mode						35.0	-59.0	-95.0	41.0	-60.0	-101.0			



4.6 TEST 4.6: ANTENNA FRONT, 6:00

WiFi Performance with Antenna Position: Front-6:00

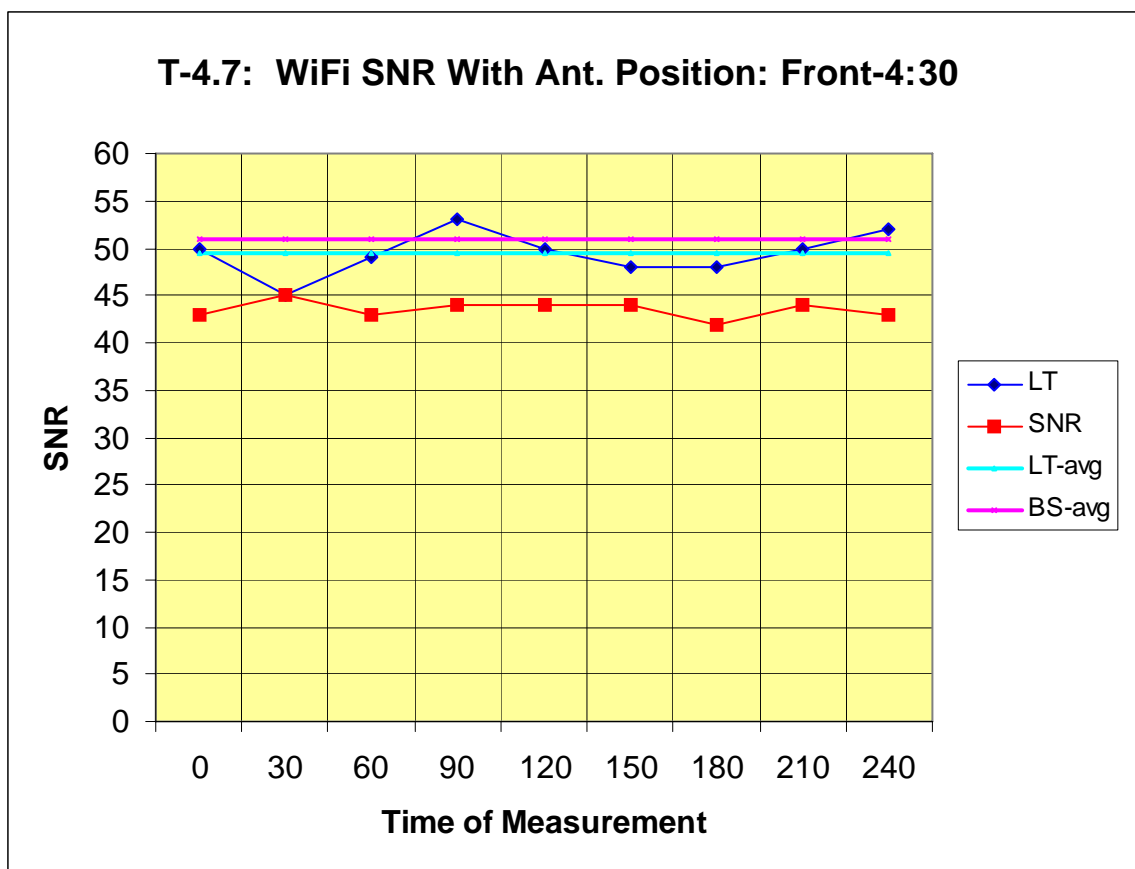
Test	4.6													
Date	3/28/03					Time	12:35							
Location						EDL Advanced Network Development Lab								
Test Coordinator:						W. Harris								
Test Personnel:														
Hardware:						Laptop	#BH			Base station:	EDL-lab1			
Address:						00-02-2D-6E-A2-F4			00-50-F2-C7-21-6C					
Encryption (WEP):						128 bit			Firewall:	on	Pings:	Open		
Test Equipment:						Laptop built-in measuring software					Cal:	new		
Antenna:						Front-6:00 (180-deg CW)								
Distance:						25 ft								
						Laptop						Base station		Comments
Test	Time	Speed (Mbps)					SNR	Signal	Noise	SNR	Signal	Noise	Avg	Avg
Run	sec	11	5.5	2	1			dB	dB		dB	dB	SNR	SNR
4.6.1	0	100	0	0	0	47	-48	-95	49	-53	-101	45.6	48.6	
4.6.2	30	100	0	0	0	45	-50	-91	49	-54	-101	45.6	48.6	
4.6.3	60	100	0	0	0	45	-50	-95	49	-54	-101	45.6	48.6	
4.6.4	90	100	0	0	0	45	-50	-93	47	-54	-101	45.6	48.6	
4.6.5	120	100	0	0	0	42	-49	-92	49	-54	-101	45.6	48.6	
4.6.6	150	100	0	0	0	45	-49	-94	49	-54	-101	45.6	48.6	
4.6.7	180	100	0	0	0	48	-49	-95	47	-53	-101	45.6	48.6	
4.6.8	210	100	0	0	0	48	-50	-97	49	-54	-101	45.6	48.6	
4.6.9	240	100	0	0	0	45	-49	-93	49	-52	-101	45.6	48.6	
Avg						45.6	-49.3	-93.9	48.6	-53.6	-101.0			
Median						45.0	-49.0	-94.0	49.0	-54.0	-101.0			
Std Dev						1.9	0.7	1.8	0.9	0.7	0.0			
Mode						45.0	-50.0	-95.0	49.0	-54.0	-101.0			



4.7 TEST 4.7: ANTENNA FRONT, 4:30

WiFi Performance with Antenna Position: Front-4:30

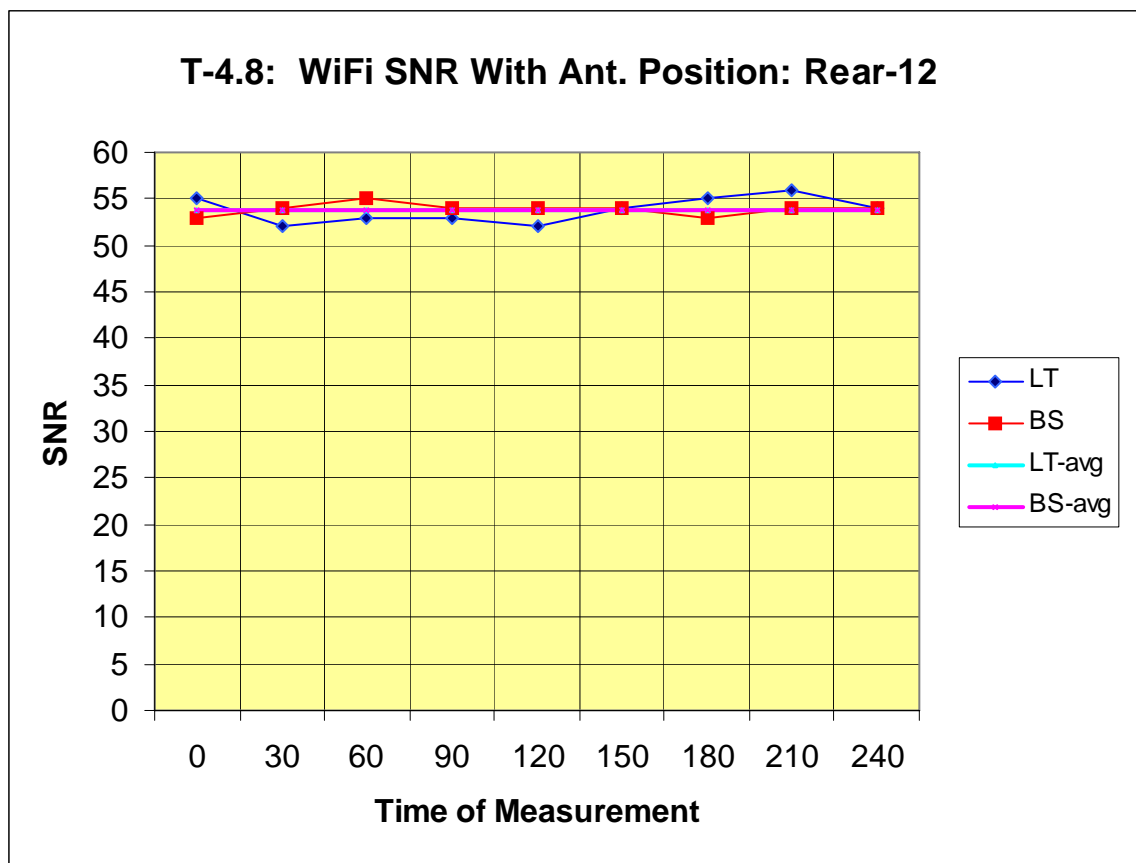
Test	4.7													
Date	3/28/03					Time	12:45							
Location						EDL Advanced Network Development Lab								
Test Coordinator:						W. Harris								
Test Personnel:														
Hardware:						Laptop #BH						Base station:EDL-lab1		
Address:						00-02-2D-6E-A2-F4						00-50-F2-C7-21-6C		
Encryption (WEP):						128 bit						Firewall: on	Pings: Open	
Test Equipment:						Laptop built-in measuring software						Cal: new		
Antenna:						Front-4:30 (135-deg CW)								
Distance:						25 ft								
						Laptop			Base station			LT	BS	Comments
Test	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	Avg	Avg	
Run	sec	11	5.5	2	1		dB	dB		dB	dB	SNR	SNR	
4.7.1	0	100	0	0	0	50	-46	-94	51	-52	-101	49.4	51.0	
4.7.2	30	100	0	0	0	45	-44	-96	53	-50	-101	49.4	51.0	
4.7.3	60	100	0	0	0	49	-45	-93	51	-50	-101	49.4	51.0	
4.7.4	90	100	0	0	0	53	-44	-98	49	-53	-101	49.4	51.0	
4.7.5	120	100	0	0	0	50	-44	-94	51	-50	-101	49.4	51.0	
4.7.6	150	100	0	0	0	48	-44	-92	51	-50	-101	49.4	51.0	
4.7.7	180	100	0	0	0	48	-44	-92	51	-50	-101	49.4	51.0	
4.7.8	210	100	0	0	0	50	-44	-94	51	-50	-101	49.4	51.0	
4.7.9	240	100	0	0	0	52	-44	-95	51	-50	-101	49.4	51.0	
Avg						49.4	-44.3	-94.2	51.0	-50.6	-101.0			
Median						50.0	-44.0	-94.0	51.0	-50.0	-101.0			
Std Dev						2.4	0.7	1.9	1.0	1.1	0.0			
Mode						50.0	-44.0	-94.0	51.0	-50.0	-101.0			



4.8 TEST 4.8: ANTENNA FRONT, 3:00

WiFi Performance with Antenna Position: Front-3:00

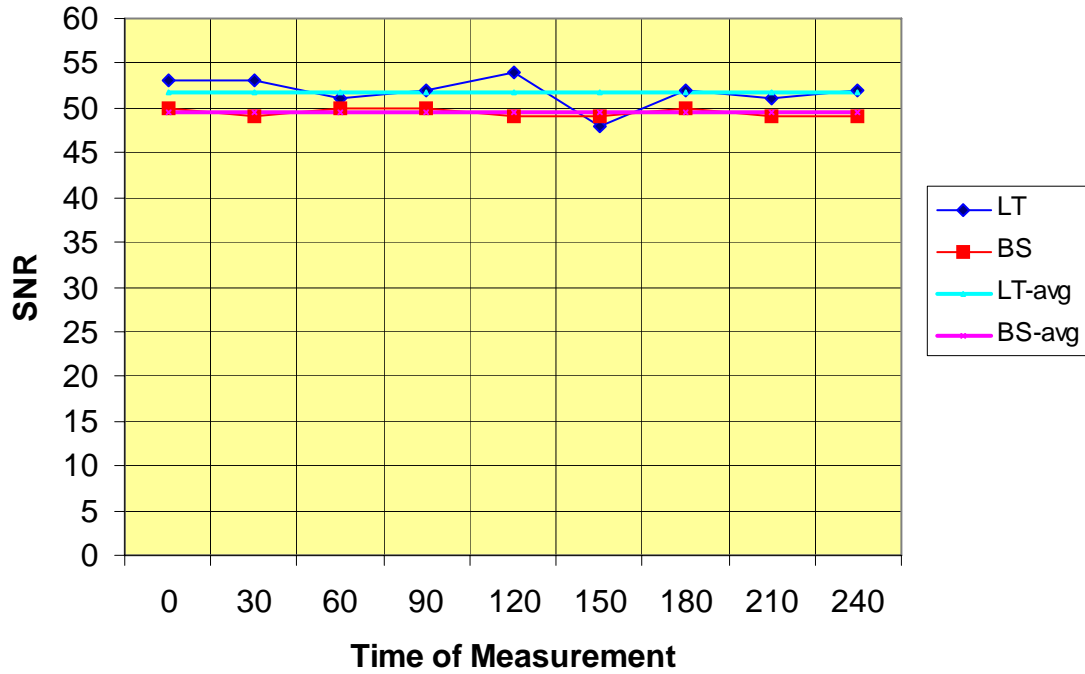
Test	4.8															
Date	3/28/03					Time	12:50									
Location						EDL Advanced Network Development Lab										
Test Coordinator:						W. Harris										
Test Personnel:																
Hardware:						Laptop	#BH			Base station	EDL-lab1					
Address:						00-02-2D-6E-A2-F4			00-50-F2-C7-21-6C							
Encryption (WEP):						128 bit			Firewall:		on	Pings:	Open			
Test Equipment:						Laptop built-in measuring software						Cal:	new			
Antenna:						Front-3:00 (90-deg CW)										
Distance:						25 ft										
						Laptop				Base station			LT	BS	Comments	
Test	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	Avg	Avg			
Run	sec	11	5.5	2	1		dB	dB		dB	dB	SNR	SNR			
4.8.1	0	100	0	0	0	55	-41	-97	53	-49	-101	53.8	53.9			
4.8.2	30	100	0	0	0	52	-40	-92	54	-48	-101	53.8	53.9			
4.8.3	60	100	0	0	0	53	-40	-93	55	-48	-101	53.8	53.9			
4.8.4	90	100	0	0	0	53	-40	-94	54	-48	-101	53.8	53.9			
4.8.5	120	100	0	0	0	52	-41	-92	54	-48	-101	53.8	53.9			
4.8.6	150	100	0	0	0	54	-41	-96	54	-48	-101	53.8	53.9			
4.8.7	180	100	0	0	0	55	-40	-96	53	-48	-101	53.8	53.9			
4.8.8	210	100	0	0	0	56	-40	-96	54	-48	-101	53.8	53.9			
4.8.9	240	100	0	0	0	54	-41	-94	54	-48	-101	53.8	53.9			
Avg						53.8	-40.4	-94.4	53.9	-48.1	-101.0					
Median						54.0	-40.0	-94.0	54.0	-48.0	-101.0					
Std Dev						1.4	0.5	1.9	0.6	0.3	0.0					
Mode						55.0	-40.0	-96.0	54.0	-48.0	-101.0					



4.9 TEST 4.9: ANTENNA FRONT, 1:30

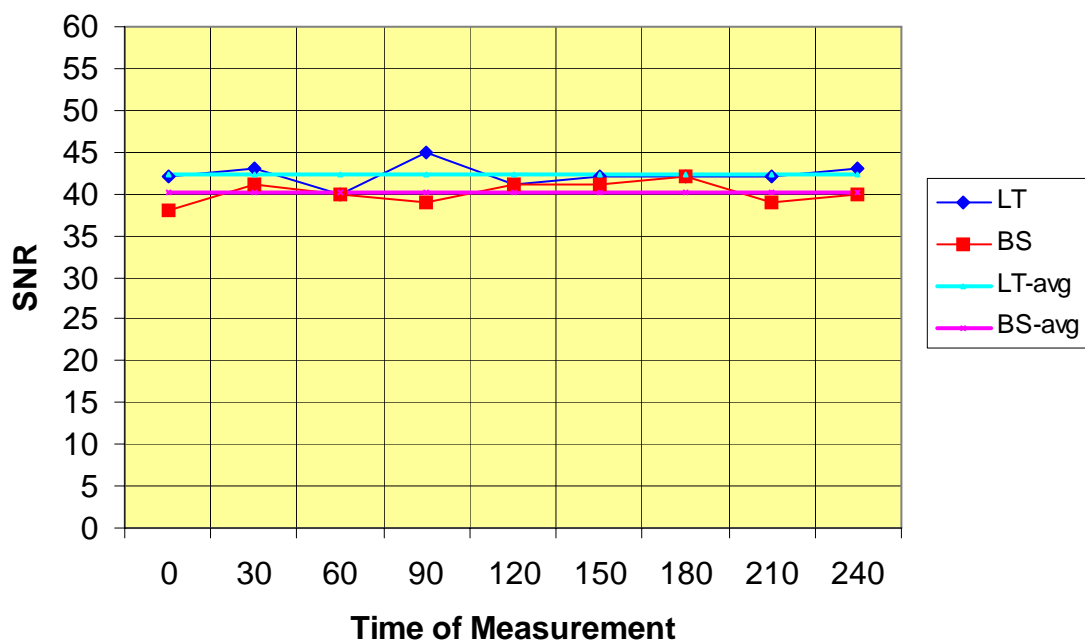
WiFi Performance with Antenna Position: Front-1:30

Test	4.9													
Date	3/28/03					Time	13:00							
Location						EDL Advanced Network Development Lab								
Test Coordinator:						W. Harris								
Test Personnel:														
Hardware:						Laptop #BH						Base station	EDL-lab1	
Address:						00-02-2D-6E-A2-F4						00-50-F2-C7-21-6C		
Encryption (WEP):						128 bit						Firewall:	on	Pings: Open
Test Equipment:						Laptop built-in measuring software						Cal:	new	
Antenna:						Front-1:30 (45-deg CW)								
Distance:						25 ft								
						Laptop			Base station			LT	BS	Comments
Test	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	Avg	Avg	
Run	sec	11	5.5	2	1		dB	dB		dB	dB	SNR	SNR	
4.9.1	0	100	0	0	0	53	-43	-96	50	-50	-100	51.8	49.4	
4.9.2	30	100	0	0	0	53	-43	-95	49	-50	-100	51.8	49.4	
4.9.3	60	100	0	0	0	51	-43	-94	50	-50	-100	51.8	49.4	
4.9.4	90	100	0	0	0	52	-42	-94	50	-50	-100	51.8	49.4	
4.9.5	120	100	0	0	0	54	-42	-96	49	-50	-100	51.8	49.4	
4.9.6	150	100	0	0	0	48	-43	-91	49	-51	-100	51.8	49.4	
4.9.7	180	100	0	0	0	52	-42	-94	50	-50	-100	51.8	49.4	
4.9.8	210	100	0	0	0	51	-42	-94	49	-52	-100	51.8	49.4	
4.9.9	240	100	0	0	0	52	-43	-94	49	-51	-100	51.8	49.4	
Avg						51.8	-42.6	-94.2	49.4	-50.4	-100.0			
Median						52.0	-43.0	-94.0	49.0	-50.0	-100.0			
Std Dev						1.7	0.5	1.5	0.5	0.7	0.0			
Mode						52.0	-43.0	-94.0	49.0	-50.0	-100.0			

T-4.9: WiFi SNR With Ant. Position: Front-1:30

4.10 TEST 4.10: ANTENNA FRONT, 12:00**WiFi Performance with Antenna Position: Front-12:00**

Test	4.10													
Date	3/28/03					Time	13:10							
Location						EDL Advanced Network Development Lab								
Test Coordinator:						W. Harris								
Test Personnel:														
Hardware:						Laptop	#BH			Base station:	EDL-lab1			
Address:						00-02-2D-6E-A2-F4			00-50-F2-C7-21-6C					
Encryption (WEP):						128 bit			Firewall:	on	Pings:	Open		
Test Equipment:						Laptop built-in measuring software					Cal:	new		
Antenna:						Front-12:00 (Vertical)								
Distance:						25 ft								
						Laptop						Base station		Comments
Test	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	Avg	Avg	
Run	sec	11	5.5	2	1		dB	dB		dB	dB	SNR	SNR	
4.10.1	0	100	0	0	0	42	-51	-94	38	-60	-100	42.2	40.1	
4.10.2	30	100	0	0	0	43	-53	-96	41	-59	-100	42.2	40.1	
4.10.3	60	100	0	0	0	40	-53	-92	40	-58	-100	42.2	40.1	
4.10.4	90	100	0	0	0	45	-52	-97	39	-58	-100	42.2	40.1	
4.10.5	120	100	0	0	0	41	-52	-94	41	-57	-100	42.2	40.1	
4.10.6	150	100	0	0	0	42	-53	-94	41	-58	-100	42.2	40.1	
4.10.7	180	100	0	0	0	42	-52	-93	42	-57	-100	42.2	40.1	
4.10.8	210	100	0	0	0	42	-53	-95	39	-59	-100	42.2	40.1	
4.10.9	240	100	0	0	0	43	-53	-95	40	-58	-100	42.2	40.1	
Avg						42.2	-52.4	-94.4	40.1	-58.2	-100.0			
Median						42.0	-53.0	-94.0	40.0	-58.0	-100.0			
Std Dev						1.4	0.7	1.5	1.3	1.0	0.0			
Mode						42.0	-53.0	-94.0	41.0	-58.0	-100.0			

T-4.10: WiFi SNR With Ant. Position: Front-1:30

5.0 TEST 5: PERFORMANCE VERSUS DISTANCE

5.1 TEST 5.1: PERFORMANCE VS DISTANCE (EDL-LAB1)

WiFi Performance With Distance (EDL-lab1)

Test	5.1													
Date	4/2/03				Time	430	AM							
Location					EDL first floor hall & parking lot									
Test Coordinator:					W. Harris									
Test Personnel:					none									
Hardware:					Laptop #BH			Base station:		EDL-lab1				
Address:					00-02-2D-6E-A2-F4				00-50-F2-C7-21-6C					
Encryption (WEP):					128 bit			Firewall:		on	Pings:	Open		
Test Equipment:					Laptop built-in measuring software						Cal:	new		
Antenna:					Rear-12:00 (Vertical)									
Distance:					Variable									
				Laptop								Base station		Comments
Run	Dist	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise		
	Ft	Sec	11	5.5	2	1		dB	dB		dB	dB		
5.1.1.1	10	0	100	0	0	0	53	-42	-95	48	-50	-98		
5.1.1.2	10	30	100	0	0	0	51	-43	-94	48	-50	-99		
5.1.1.3	10	60	100	0	0	0	50	-42	-92	48	-51	-98		
5.1.1.4	10	90	100	0	0	0	52	-42	-94	47	-51	-98		
5.1.1.5	10	120	100	0	0	0	53	-43	-96	47	-51	-98		
5.1.1.6	10	150	100	0	0	0	49	-42	-92	47	-50	-98		
5.1.1.7	10	180	100	0	0	0	52	-43	-94	46	-51	-98		
Avg			100.0	0.0	0.0	0.0	51.4	-42.4	-93.9	47.3	-50.6	-98.1		
Median			100.0	0.0	0.0	0.0	52.0	-42.0	-94.0	47.0	-51.0	-98.0		
Std Dev			0.0	0.0	0.0	0.0	1.5	0.5	1.5	0.8	0.5	0.4		
Mode			100.0	0.0	0.0	0.0	53.0	-42.0	-94.0	48.0	-51.0	-98.0		
5.1.2.1	20	0	100	0	0	0	45	-50	-94	41	-56	-98		
5.1.2.2	20	30	100	0	0	0	46	-50	-94	41	-57	-98		
5.1.2.3	20	60	100	0	0	0	45	-49	-94	43	-56	-98		
5.1.2.4	20	90	100	0	0	0	47	-50	-96	43	-55	-98		
5.1.2.5	20	120	100	0	0	0	44	-50	-95	42	-56	-98		
5.1.2.6	20	150	100	0	0	0	43	-50	-93	43	-55	-98		
5.1.2.7	20	180	100	0	0	0	45	-50	-95	43	-54	-98		
Avg			100.0	0.0	0.0	0.0	45.0	-49.9	-94.4	42.3	-55.6	-98.0		
Median			100.0	0.0	0.0	0.0	45.0	-50.0	-94.0	43.0	-56.0	-98.0		
Std Dev			0.0	0.0	0.0	0.0	1.3	0.4	1.0	1.0	1.0	0.0		
Mode			100.0	0.0	0.0	0.0	45.0	-50.0	-94.0	43.0	-56.0	-98.0		
5.1.3.1	30	0	100	0	0	0	37	-55	-92	38	-61	-97		
5.1.3.2	30	30	100	0	0	0	40	-56	-94	39	-60	-98		
5.1.3.3	30	60	100	0	0	0	43	-54	-97	38	-60	-98		
5.1.3.4	30	90	100	0	0	0	38	-56	-93	37	-60	-98		
5.1.3.5	30	120	100	0	0	0	38	-56	-92	39	-60	-98		
5.1.3.6	30	150	100	0	0	0	36	-56	-92	38	-60	-98		
5.1.3.7	30	180	100	0	0	0	39	-56	-93	38	-60	-98		
Avg			100.0	0.0	0.0	0.0	38.7	-55.6	-93.3	38.1	-60.1	-97.9		
Median			100.0	0.0	0.0	0.0	38.0	-56.0	-93.0	38.0	-60.0	-98.0		
Std Dev			0.0	0.0	0.0	0.0	2.3	0.8	1.8	0.7	0.4	0.4		
Mode			100.0	0.0	0.0	0.0	38.0	-56.0	-92.0	38.0	-60.0	-98.0		

5.1.4.1	40	0	100	0	0	0	36	-57	-93	36	-64	-99	
5.1.4.2	40	30	100	0	0	0	41	-55	-95	37	-64	-98	
5.1.4.3	40	60	100	0	0	0	40	-56	-95	37	-60	-98	
5.1.4.4	40	90	100	0	0	0	38	-55	-94	37	-60	-98	
5.1.4.5	40	120	100	0	0	0	37	-57	-95	34	-63	-98	
5.1.4.6	40	150	100	0	0	0	41	-56	-95	39	-60	-98	
5.1.4.7	40	180	100	0	0	0	35	-57	-93	33	-64	-98	
Avg			100.0	0.0	0.0	0.0	38.3	-56.1	-94.3	36.1	-62.1	-98.1	
Median			100.0	0.0	0.0	0.0	38.0	-56.0	-95.0	37.0	-63.0	-98.0	
Std Dev			0.0	0.0	0.0	0.0	2.4	0.9	1.0	2.0	2.0	0.4	
Mode			100.0	0.0	0.0	0.0	41.0	-57.0	-95.0	37.0	-64.0	-98.0	
5.1.5.1	50	0	100	0	0	0	36	-59	-95	34	-64	-98	
5.1.5.2	50	30	100	0	0	0	35	-58	-92	34	-63	-98	
5.1.5.3	50	60	100	0	0	0	40	-57	-97	35	-63	-98	
5.1.5.4	50	90	100	0	0	0	37	-58	-95	34	-64	-98	
5.1.5.5	50	120	100	0	0	0	34	-58	-92	34	-64	-98	
5.1.5.6	50	150	100	0	0	0	37	-59	-95	34	-65	-98	
5.1.5.7	50	180	100	0	0	0	39	-56	-95	35	-62	-98	
Avg			100.0	0.0	0.0	0.0	36.9	-57.9	-94.4	34.3	-63.6	-98.0	
Median			100.0	0.0	0.0	0.0	37.0	-58.0	-95.0	34.0	-64.0	-98.0	
Std Dev			0.0	0.0	0.0	0.0	2.1	1.1	1.8	0.5	1.0	0.0	
Mode			100.0	0.0	0.0	0.0	37.0	-58.0	-95.0	34.0	-64.0	-98.0	
5.1.6.1	60	0	100	0	0	0	42	-53	-96	39	-59	-97	
5.1.6.2	60	30	100	0	0	0	42	-53	-96	38	-60	-98	
5.1.6.3	60	60	100	0	0	0	38	-53	-92	38	-59	-98	
5.1.6.4	60	90	100	0	0	0	41	-54	-95	38	-60	-98	
5.1.6.5	60	120	100	0	0	0	41	-54	-95	40	-60	-99	
5.1.6.6	60	150	100	0	0	0	39	-54	-93	38	-59	-98	
5.1.6.7	60	180	100	0	0	0	40	-54	-94	39	-60	-98	
Avg			100.0	0.0	0.0	0.0	40.4	-53.6	-94.4	38.6	-59.6	-98.0	
Median			100.0	0.0	0.0	0.0	41.0	-54.0	-95.0	38.0	-60.0	-98.0	
Std Dev			0.0	0.0	0.0	0.0	1.5	0.5	1.5	0.8	0.5	0.6	
Mode			100.0	0.0	0.0	0.0	42.0	-54.0	-96.0	38.0	-60.0	-98.0	
5.1.7.1	70	0	48	42	9	0	34	-59	-94	29	-69	-98	
5.1.7.2	70	30	69	26	4	0	33	-58	-93	27	-70	-98	
5.1.7.3	70	60	68	27	4	0	36	-59	-95	29	-70	-98	
5.1.7.4	70	90	63	31	4	0	35	-60	-94	29	-69	-98	
5.1.7.5	70	120	61	34	3	0	37	-59	-98	27	-71	-98	
5.1.7.6	70	150	63	32	3	0	31	-63	-95	29	-70	-99	
5.1.7.7	70	180	66	30	2	0	32	-59	-92	28	-69	-98	
Avg			62.6	31.7	4.1	0.0	34.0	-59.6	-94.4	28.3	-69.7	-98.1	
Median			63.0	31.0	4.0	0.0	34.0	-59.0	-94.0	29.0	-70.0	-98.0	
Std Dev			7.0	5.3	2.3	0.0	2.2	1.6	1.9	1.0	0.8	0.4	
Mode			63.0	#N/A	4.0	0.0	#N/A	-59.0	-94.0	29.0	-69.0	-98.0	

ECT Phase 2 – Vol. 2 – Appendices

5.1.8.1	80	0	100	0	0	0	36	-58	-94	33	-64	-98	
5.1.8.2	80	30	100	0	0	0	38	-57	-96	33	-65	-98	
5.1.8.3	80	60	100	0	0	0	36	-59	-94	33	-65	-98	
5.1.8.4	80	90	100	0	0	0	34	-59	-93	33	-65	-98	
5.1.8.5	80	120	100	0	0	0	35	-59	-94	33	-65	-98	
5.1.8.6	80	150	100	0	0	0	37	-57	-95	34	-65	-98	
5.1.8.7	80	180	100	0	0	0	36	-58	-94	33	-64	-98	
Avg			100.0	0.0	0.0	0.0	36.0	-58.1	-94.3	33.1	-64.7	-98.0	
Median			100.0	0.0	0.0	0.0	36.0	-58.0	-94.0	33.0	-65.0	-98.0	
Std Dev			0.0	0.0	0.0	0.0	1.3	0.9	1.0	0.4	0.5	0.0	
Mode			100.0	0.0	0.0	0.0	36.0	-59.0	-94.0	33.0	-65.0	-98.0	
5.1.9.1	90	0	87	12	0	0	34	-62	-96	27	-71	-98	
5.1.9.2	90	30	90	9	0	0	31	-63	-95	28	-70	-98	
5.1.9.3	90	60	85	14	0	0	34	-63	-96	26	-71	-98	
5.1.9.4	90	90	77	22	0	0	30	-63	-94	27	-71	-98	
5.1.9.5	90	120	79	20	0	0	33	-63	-96	30	-70	-98	
5.1.9.6	90	150	80	19	0	0	31	-62	-94	28	-70	-98	
5.1.9.7	90	180	81	18	0	0	31	-63	-94	27	-71	-98	
Avg			82.7	16.3	0.0	0.0	32.0	-62.7	-95.0	27.6	-70.6	-98.0	
Median			81.0	18.0	0.0	0.0	31.0	-63.0	-95.0	27.0	-71.0	-98.0	
Std Dev			4.7	4.7	0.0	0.0	1.6	0.5	1.0	1.3	0.5	0.0	
Mode			#N/A	#N/A	0.0	0.0	31.0	-63.0	-96.0	27.0	-71.0	-98.0	
5.1.10.1	100	0	100	0	0	0	26	-66	-92	28	-69	-97	
5.1.10.2	100	30	100	0	0	0	28	-65	-95	28	-69	-98	
5.1.10.3	100	60	100	0	0	0	27	-65	-92	29	-68	-98	
5.1.10.4	100	90	100	0	0	0	27	-65	-93	27	-70	-98	
5.1.10.5	100	120	100	0	0	0	29	-66	-95	28	-70	-98	
5.1.10.6	100	150	100	0	0	0	30	-66	-95	29	-68	-98	
5.1.10.7	100	180	100	0	0	0	31	-66	-95	29	-70	-98	
Avg			100.0	0.0	0.0	0.0	28.3	-65.6	-93.9	28.3	-69.1	-97.9	
Median			100.0	0.0	0.0	0.0	28.0	-66.0	-95.0	28.0	-69.0	-98.0	
Std Dev			0.0	0.0	0.0	0.0	1.8	0.5	1.5	0.8	0.9	0.4	
Mode			100.0	0.0	0.0	0.0	27.0	-66.0	-95.0	28.0	-70.0	-98.0	
5.1.11.1	110	0	100	0	0	0	30	-63	-93	32	-66	-98	
5.1.11.2	110	30	100	0	0	0	30	-62	-93	31	-66	-98	
5.1.11.3	110	60	100	0	0	0	30	-62	-92	32	-66	-98	
5.1.11.4	110	90	100	0	0	0	31	-62	-93	31	-66	-98	
5.1.11.5	110	120	100	0	0	0	32	-63	-95	32	-66	-98	
5.1.11.6	110	150	100	0	0	0	31	-62	-94	31	-66	-98	
5.1.11.7	110	180	100	0	0	0	28	-63	-92	31	-66	-98	
Avg			100.0	0.0	0.0	0.0	30.3	-62.4	-93.1	31.4	-66.0	-98.0	
Median			100.0	0.0	0.0	0.0	30.0	-62.0	-93.0	31.0	-66.0	-98.0	
Std Dev			0.0	0.0	0.0	0.0	1.3	0.5	1.1	0.5	0.0	0.0	
Mode			100.0	0.0	0.0	0.0	30.0	-62.0	-93.0	31.0	-66.0	-98.0	

ECT Phase 2 – Vol. 2 – Appendices

5.1.12.1	120	0	100	0	0	0	29	-64	-93	32	-67	-98	
5.1.12.2	120	30	100	0	0	0	30	-63	-93	31	-68	-98	
5.1.12.3	120	60	100	0	0	0	29	-64	-93	31	-68	-98	
5.1.12.4	120	90	100	0	0	0	28	-64	-93	29	-68	-98	
5.1.12.5	120	120	99	0	0	0	28	-64	-93	31	-67	-98	
5.1.12.6	120	150	99	0	0	0	32	-64	-95	31	-68	-98	
5.1.12.7	120	180	99	0	0	0	27	-65	-91	30	-68	-98	
Avg			99.6	0.0	0.0	0.0	29.0	-64.0	-93.0	30.7	-67.7	-98.0	
Median			100.0	0.0	0.0	0.0	29.0	-64.0	-93.0	31.0	-68.0	-98.0	
Std Dev			0.5	0.0	0.0	0.0	1.6	0.6	1.2	1.0	0.5	0.0	
Mode			100.0	0.0	0.0	0.0	29.0	-64.0	-93.0	31.0	-68.0	-98.0	
5.1.13.1	130	0	100	0	0	0	24	-70	-92	26	-72	-98	
5.1.13.2	130	30	100	0	0	0	24	-68	-92	28	-70	-98	
5.1.13.3	130	60	100	0	0	0	24	-70	-94	25	-73	-98	
5.1.13.4	130	90	100	0	0	0	25	-69	-95	27	-71	-98	
5.1.13.5	130	120	100	0	0	0	24	-70	-93	26	-72	-98	
5.1.13.6	130	150	100	0	0	0	21	-72	-94	23	-74	-98	
5.1.13.7	130	180	100	0	0	0	23	-70	-94	26	-72	-98	
Avg			100.0	0.0	0.0	0.0	23.6	-69.9	-93.4	25.9	-72.0	-98.0	
Median			100.0	0.0	0.0	0.0	24.0	-70.0	-94.0	26.0	-72.0	-98.0	
Std Dev			0.0	0.0	0.0	0.0	1.3	1.2	1.1	1.6	1.3	0.0	
Mode			100.0	0.0	0.0	0.0	24.0	-70.0	-94.0	26.0	-72.0	-98.0	
5.1.14.1	140	0	20	68	11	0	21	-71	-92	28	-70	-98	
5.1.14.2	140	30	11	78	10	0	23	-72	-94	24	-74	-98	
5.1.14.3	140	60	19	74	6	0	21	-73	-93	25	-73	-98	
5.1.14.4	140	90	20	74	4	0	20	-73	-94	25	-73	-98	
5.1.14.5	140	120											lost signal
5.1.14.6	140	150	17	78	3	0	21	-74	-95	26	-72	-98	
5.1.14.7	140	180	24	72	3	0	22	-72	-94	25	-74	-98	
Avg			18.5	74.0	6.2	0.0	21.3	-72.5	-93.7	25.5	-72.7	-98.0	
Median			19.5	74.0	5.0	0.0	21.0	-72.5	-94.0	25.0	-73.0	-98.0	
Std Dev			4.3	3.8	3.5	0.0	1.0	1.0	1.0	1.4	1.5	0.0	
Mode			20.0	78.0	3.0	0.0	21.0	-72.0	-94.0	25.0	-74.0	-98.0	
5.1.15.1	150	0	42	57	0	0	27	-68	-94	28	-70	-98	
5.1.15.2	150	30	64	35	0	0	25	-68	-93	27	-70	-98	
5.1.15.3	150	60	72	27	0	0	26	-68	-94	27	-70	-98	
5.1.15.4	150	90	70	29	0	0	25	-69	-94	25	-72	-98	
5.1.15.5	150	120	76	23	0	0	25	-66	-90	27	-70	-98	
5.1.15.6	150	150	79	20	0	0	24	-68	-92	25	-72	-98	
5.1.15.7	150	180	75	24	0	0	23	-70	-93	26	-72	-98	
Avg			68.3	30.7	0.0	0.0	25.0	-68.1	-92.9	26.4	-70.9	-98.0	
Median			72.0	27.0	0.0	0.0	25.0	-68.0	-93.0	27.0	-70.0	-98.0	
Std Dev			12.6	12.6	0.0	0.0	1.3	1.2	1.5	1.1	1.1	0.0	
Mode			#N/A	#N/A	0.0	0.0	25.0	-68.0	-94.0	27.0	-70.0	-98.0	

ECT Phase 2 – Vol. 2 – Appendices

5.1.16.1	160	0	100	0	0	0	24	-70	-93	25	-72	-98	
5.1.16.2	160	30	100	0	0	0	25	-69	-94	26	-72	-98	
5.1.16.3	160	60	93	5	1	0	25	-71	-95	23	-75	-98	
5.1.16.4	160	90	87	5	5	0	21	-71	-92	20	-77	-98	
5.1.16.5	160	120	81	9	6	2	24	-70	-94	22	-75	-98	
5.1.16.6	160	150	83	8	5	2	23	-70	-93	25	-73	-98	
5.1.16.7	160	180	81	9	7	1	25	-69	-94	25	-72	-98	
Avg			89.3	5.1	3.4	0.7	23.9	-70.0	-93.6	23.7	-73.7	-98.0	
Median			87.0	5.0	5.0	0.0	24.0	-70.0	-94.0	25.0	-73.0	-98.0	
Std Dev			8.4	3.9	3.0	1.0	1.5	0.8	1.0	2.1	2.0	0.0	
Mode			100.0	0.0	0.0	0.0	25.0	-70.0	-94.0	25.0	-72.0	-98.0	
5.1.17.1	170	0	100	0	0	0	23	-70	-92	26	-72	-98	
5.1.17.2	170	30	100	0	0	0	21	-71	-92	23	-74	-98	
5.1.17.3	170	60	100	0	0	0	22	-71	-92	25	-73	-98	
5.1.17.4	170	90	100	0	0	0	25	-69	-95	26	-72	-98	
5.1.17.5	170	120	100	0	0	0	24	-69	-95	26	-72	-98	
5.1.17.6	170	150	100	0	0	0	24	-71	-95	25	-73	-98	
5.1.17.7	170	180	100	0	0	0	22	-71	-93	25	-72	-98	
Avg			100.0	0.0	0.0	0.0	23.0	-70.3	-93.4	25.1	-72.6	-98.0	
Median			100.0	0.0	0.0	0.0	23.0	-71.0	-93.0	25.0	-72.0	-98.0	
Std Dev			0.0	0.0	0.0	0.0	1.4	1.0	1.5	1.1	0.8	0.0	
Mode			100.0	0.0	0.0	0.0	22.0	-71.0	-92.0	26.0	-72.0	-98.0	
5.1.18.1	180	0	21	58	19	0	21	-73	-93	20	-77	-98	
5.1.18.2	180	30	23	66	10	0	24	-72	-95	20	-77	-98	
5.1.18.3	180	60	31	61	6	0	20	-73	-94	22	-75	-98	
5.1.18.4	180	90	35	59	4	0	22	-73	-95	21	-76	-98	
5.1.18.5	180	120	36	59	3	0	21	-73	-94	22	-75	-98	
5.1.18.6	180	150	37	58	3	0	23	-72	-96	21	-76	-98	
5.1.18.7	180	180	36	59	3	0	20	-73	-93	22	-76	-98	
Avg			31.3	60.0	6.9	0.0	21.6	-72.7	-94.3	21.1	-76.0	-98.0	
Median			35.0	59.0	4.0	0.0	21.0	-73.0	-94.0	21.0	-76.0	-98.0	
Std Dev			6.7	2.8	5.9	0.0	1.5	0.5	1.1	0.9	0.8	0.0	
Mode			36.0	59.0	3.0	0.0	21.0	-73.0	-93.0	22.0	-76.0	-98.0	
5.1.19.1	190	0	100	0	0	0	23	-70	-94	26	-71	-98	
5.1.19.2	190	30	100	0	0	0	24	-69	-95	26	-71	-98	
5.1.19.3	190	60	98	1	0	0	23	-69	-93	26	-71	-98	
5.1.19.4	190	90	98	1	0	0	23	-70	-92	28	-70	-98	
5.1.19.5	190	120	99	0	0	0	27	-68	-96	27	-70	-98	
5.1.19.6	190	150	99	0	0	0	26	-69	-95	26	-71	-98	
5.1.19.7	190	180	99	0	0	0	26	-69	-96	26	-71	-98	

ECT Phase 2 – Vol. 2 – Appendices

5.1.20.1	200	0	100	0	0	0	22	-73	-96	23	-75	-98	
5.1.20.2	200	30	100	0	0	0	22	-71	-93	25	-72	-98	
5.1.20.3	200	60	100	0	0	0	23	-70	-93	25	-72	-98	
5.1.20.4	200	90	100	0	0	0	25	-71	-96	24	-73	-98	
5.1.20.5	200	120	99	0	0	0	21	-73	-94	22	-75	-97	
5.1.20.6	200	150	99	0	0	0	23	-70	-95	25	-74	-99	
5.1.20.7	200	180	99	0	0	0	27	-72	-100	23	-74	-97	
Avg			99.6	0.0	0.0	0.0	23.3	-71.4	-95.3	23.9	-73.6	-97.9	
Median			100.0	0.0	0.0	0.0	23.0	-71.0	-95.0	24.0	-74.0	-98.0	
Std Dev			0.5	0.0	0.0	0.0	2.1	1.3	2.4	1.2	1.3	0.7	
Mode			100.0	0.0	0.0	0.0	22.0	-73.0	-96.0	25.0	-75.0	-98.0	
5.1.21.1	210	0	92	7	0	0	19	-76	-94	19	-79	-98	
5.1.21.2	210	30	86	13	0	0	20	-74	-94	20	-77	-98	
5.1.21.3	210	60	93	6	0	0	21	-74	-96	20	-77	-98	
5.1.21.4	210	90	95	4	0	0	19	-74	-93	21	-77	-98	
5.1.21.5	210	120	95	4	0	0	20	-75	-94	21	-77	-98	
5.1.21.6	210	150	95	4	0	0	17	-75	-93	22	-76	-98	
5.1.21.7	210	180	96	3	0	0	20	-75	-96	19	-78	-98	
Avg			93.1	5.9	0.0	0.0	19.4	-74.7	-94.3	20.3	-77.3	-98.0	
Median			95.0	4.0	0.0	0.0	20.0	-75.0	-94.0	20.0	-77.0	-98.0	
Std Dev			3.4	3.4	0.0	0.0	1.3	0.8	1.3	1.1	1.0	0.0	
Mode			95.0	4.0	0.0	0.0	20.0	-74.0	-94.0	19.0	-77.0	-98.0	
5.1.22.1	220	0	0	0	11	95	18	-77	-95	18	-80	-98	
5.1.22.2	220	30	0	0	12	83	19	-77	-96	18	-80	-99	
5.1.22.3	220	60	0	1	13	83	21	-78	-98	18	-80	-98	
5.1.22.4	220	90	0	1	15	82	19	-76	-95	18	-80	-98	
5.1.22.5	220	120	0	1	15	82	18	-101	-96	16	-102	-98	
5.1.22.6	220	150	0	1	14	83	18	-78	-96	17	-82	-99	
5.1.22.7	220	180	0	1	15	83	17	-78	-95	17	-81	-98	
Avg			0.0	0.7	13.6	84.4	18.6	-80.7	-95.9	17.4	-83.6	-98.3	
Median			0.0	1.0	14.0	83.0	18.0	-78.0	-96.0	18.0	-80.0	-98.0	
Std Dev			0.0	0.5	1.6	4.7	1.3	9.0	1.1	0.8	8.2	0.5	
Mode			0.0	1.0	15.0	83.0	18.0	-78.0	-95.0	18.0	-80.0	-98.0	
5.1.23.1	230	0											no signal
5.1.23.2	230	30	0	0	3	96	17	-78	-95	16	-83	-98	
5.1.23.3	230	60	0	0	4	95	18	-102	-97	15	-102	-98	
5.1.23.4	230	90											no signal
5.1.23.5	230	120											no signal
5.1.23.6	230	150	6	5	8	79	17	-83	-96	15	-86	-98	
5.1.23.7	230	180											no signal
Avg			2.0	1.7	5.0	90.0	17.3	-87.7	-96.0	15.3	-90.3	-98.0	
Median			0.0	0.0	4.0	95.0	17.0	-83.0	-96.0	15.0	-86.0	-98.0	
Std Dev			3.5	2.9	2.6	9.5	0.6	12.7	1.0	0.6	10.2	0.0	
Mode			0.0	0.0	#N/A	#N/A	17.0	#N/A	#N/A	15.0	#N/A	-98.0	

ECT Phase 2 – Vol. 2 – Appendices

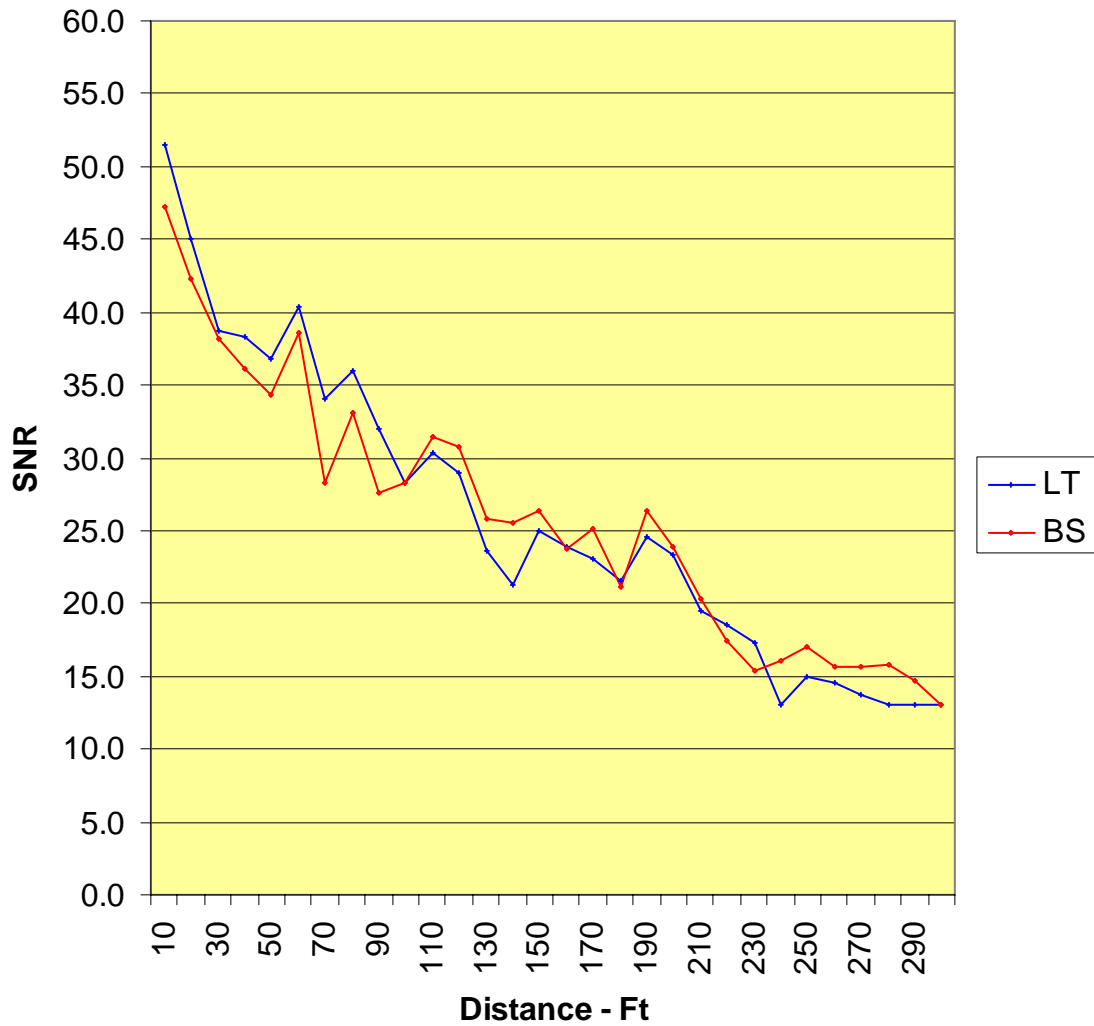
5.1.24.1	240	0											no signal
5.1.24.2	240	30											no signal
5.1.24.3	240	60											no signal
5.1.24.4	240	90	0	0	0	100	12	-102	-94	17	-102	-98	
5.1.24.5	240	120											no signal
5.1.24.6	240	150	0	0	0	100	14	-102	-98	15	-102	-98	
5.1.24.7	240	180											no signal
Avg			0.0	0.0	0.0	100.0	13.0	-102.0	-96.0	16.0	-102.0	-98.0	
Median			0.0	0.0	0.0	100.0	13.0	-102.0	-96.0	16.0	-102.0	-98.0	
Std Dev			0.0	0.0	0.0	0.0	1.4	0.0	2.8	1.4	0.0	0.0	
Mode			0.0	0.0	0.0	100.0	#N/A	-102.0	#N/A	#N/A	-102.0	-98.0	
5.1.25.1	250	0											no signal
5.1.25.2	250	30	0	0	0	100	15	-96	-95	17	-97	-97	
5.1.25.3	250	60	0	0	0	100	18	-81	-99	17	-81	-98	
5.1.25.4	250	90											no signal
5.1.25.5	250	120	0	0	0	100	12	-102	-93	17	-102	-99	
5.1.25.6	250	150											no signal
5.1.25.7	250	180											no signal
Avg			0.0	0.0	0.0	100.0	15.0	-93.0	-95.7	17.0	-93.3	-98.0	
Median			0.0	0.0	0.0	100.0	15.0	-96.0	-95.0	17.0	-97.0	-98.0	
Std Dev			0.0	0.0	0.0	0.0	3.0	10.8	3.1	0.0	11.0	1.0	
Mode			0.0	0.0	0.0	100.0	#N/A	#N/A	#N/A	17.0	#N/A	#N/A	
5.1.26.1	260	0	0	0	0	100	14	-102	-93	14	-102	-98	
5.1.26.2	260	30	0	0	0	100	14	-81	-94	14	-83	-98	
5.1.26.3	260	60	0	0	0	100	17	-78	-95	17	-81	-98	
5.1.26.4	260	90	0	0	10	89	14	-78	-93	17	-81	-98	
5.1.26.5	260	120											no signal
5.1.26.6	260	150	0	0	6	93	14	-85	-93	16	-89	-98	
5.1.26.7	260	180											no signal
Avg			0.0	0.0	3.2	96.4	14.6	-84.8	-93.6	15.6	-87.2	-98.0	
Median			0.0	0.0	0.0	100.0	14.0	-81.0	-93.0	16.0	-83.0	-98.0	
Std Dev			0.0	0.0	4.6	5.1	1.3	10.0	0.9	1.5	8.9	0.0	
Mode			0.0	0.0	0.0	100.0	14.0	-78.0	-93.0	14.0	-81.0	-98.0	
5.1.27.1	270	0	0	10	24	65	13	-82	-93	17	-84	-100	
5.1.27.2	270	30	0	7	17	75	14	-88	-93	17	-90	-99	
5.1.27.3	270	60	0	6	16	77	14	-82	-94	15	-84	-99	
5.1.27.4	270	90											no signal
5.1.27.5	270	120	0	4	12	82	13	-102	-93	15	-102	-98	
5.1.27.6	270	150	0	4	11	83	14	-102	-92	15	-102	-98	
5.1.27.7	270	180	0	3	9	86	14	-102	-94	15	-102	-98	
Avg			0.0	5.7	14.8	78.0	13.7	-93.0	-93.2	15.7	-94.0	-98.7	
Median			0.0	5.0	14.0	79.5	14.0	-95.0	-93.0	15.0	-96.0	-98.5	
Std Dev			0.0	2.6	5.4	7.5	0.5	10.1	0.8	1.0	9.0	0.8	
Mode			0.0	4.0	#N/A	#N/A	14.0	-102.0	-93.0	15.0	-102.0	-98.0	

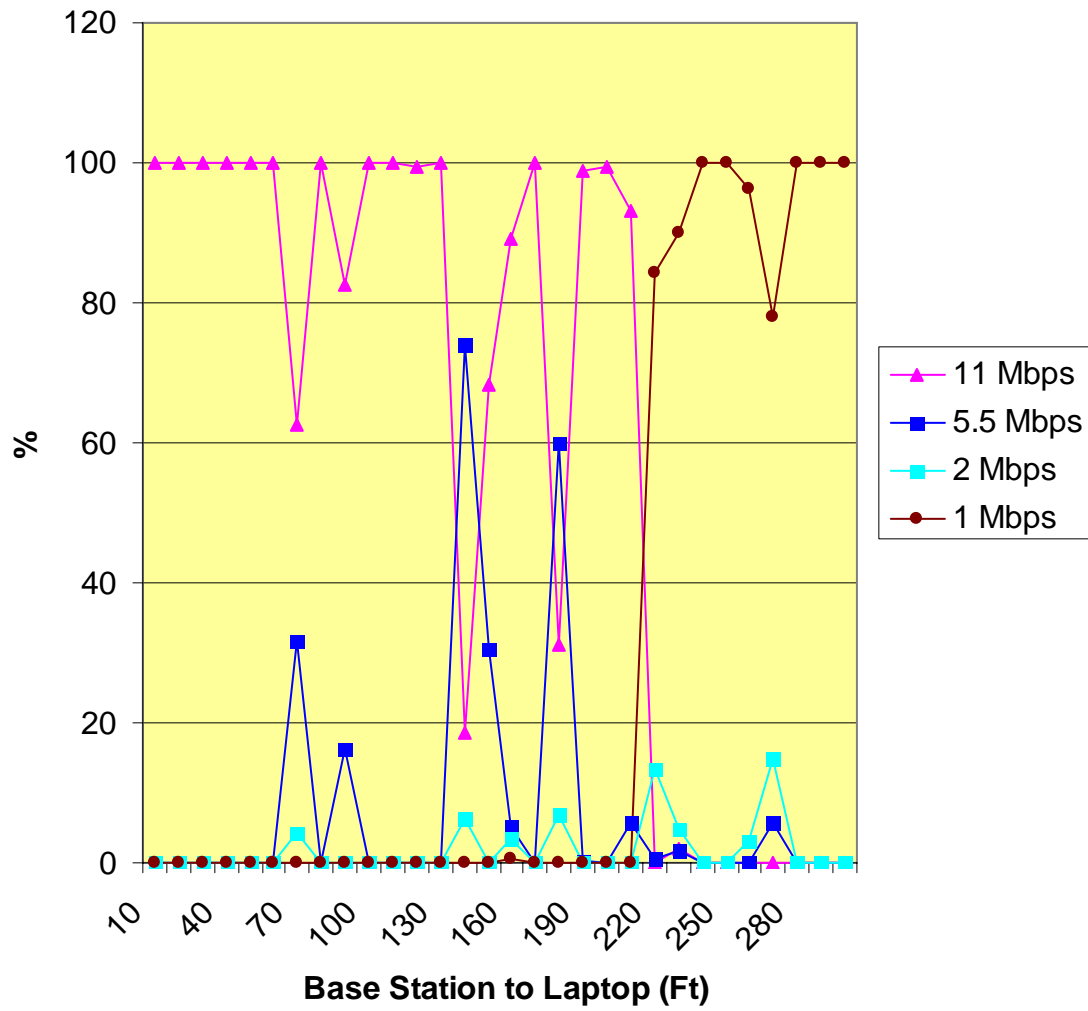
ECT Phase 2 – Vol. 2 – Appendices

5.1.28.1	280	0	0	0	0	100	13	-87	-94	15	-90	-99	
5.1.28.2	280	30											no signal
5.1.28.3	280	60	0	0	0	100	12	-102	-93	15	-102	-98	
5.1.28.4	280	90	0	0	0	100	14	-95	-93	17	-98	-100	
5.1.28.5	280	120	0	0	0	100	12	-102	-94	16	-102	-99	
5.1.28.6	280	150	0	0	0	100	14	-101	-93	16	-102	-99	
5.1.28.7	280	180											no signal
Avg			0.0	0.0	0.0	100.0	13.0	-97.4	-93.4	15.8	-98.8	-99.0	
Median			0.0	0.0	0.0	100.0	13.0	-101.0	-93.0	16.0	-102.0	-99.0	
Std Dev			0.0	0.0	0.0	0.0	1.0	6.5	0.5	0.8	5.2	0.7	
Mode			0.0	0.0	0.0	100.0	12.0	-102.0	-93.0	15.0	-102.0	-99.0	
5.1.29.1	290	0	0	0	0	100	13	-102	-95	14	-102	-99	
5.1.29.2	290	30	0	0	0	100	13	-82	-94	15	-84	-99	
5.1.29.3	290	60											no signal
5.1.29.4	290	90											no signal
5.1.29.5	290	120	0	0	0	100	13	-102	-94	16	-102	-99	
5.1.29.6	290	150	0	0	0	100	13	-102	-95	14	-102	-98	
5.1.29.7	290	180											no signal
Avg			0.0	0.0	0.0	100.0	13.0	-97.0	-94.5	14.8	-97.5	-98.8	
Median			0.0	0.0	0.0	100.0	13.0	-102.0	-94.5	14.5	-102.0	-99.0	
Std Dev			0.0	0.0	0.0	0.0	0.0	10.0	0.6	1.0	9.0	0.5	
Mode			0.0	0.0	0.0	100.0	13.0	-102.0	-95.0	14.0	-102.0	-99.0	
5.1.30.1	300	0											no signal
5.1.30.2	300	30											no signal
5.1.30.3	300	60											no signal
5.1.30.4	300	90											no signal
5.1.30.5	300	120	0	0	0	100	10	-102	-92	13	-102	-99	
5.1.30.6	300	150											no signal
5.1.30.7	300	180	0	0	0	100	16	-102	-96	13	-102	-98	
Avg			0.0	0.0	0.0	100.0	13.0	-102.0	-94.0	13.0	-102.0	-98.5	
Median			0.0	0.0	0.0	100.0	13.0	-102.0	-94.0	13.0	-102.0	-98.5	
Std Dev			0.0	0.0	0.0	0.0	4.2	0.0	2.8	0.0	0.0	0.7	
Mode			0.0	0.0	0.0	100.0	#N/A	-102.0	#N/A	13.0	-102.0	#N/A	

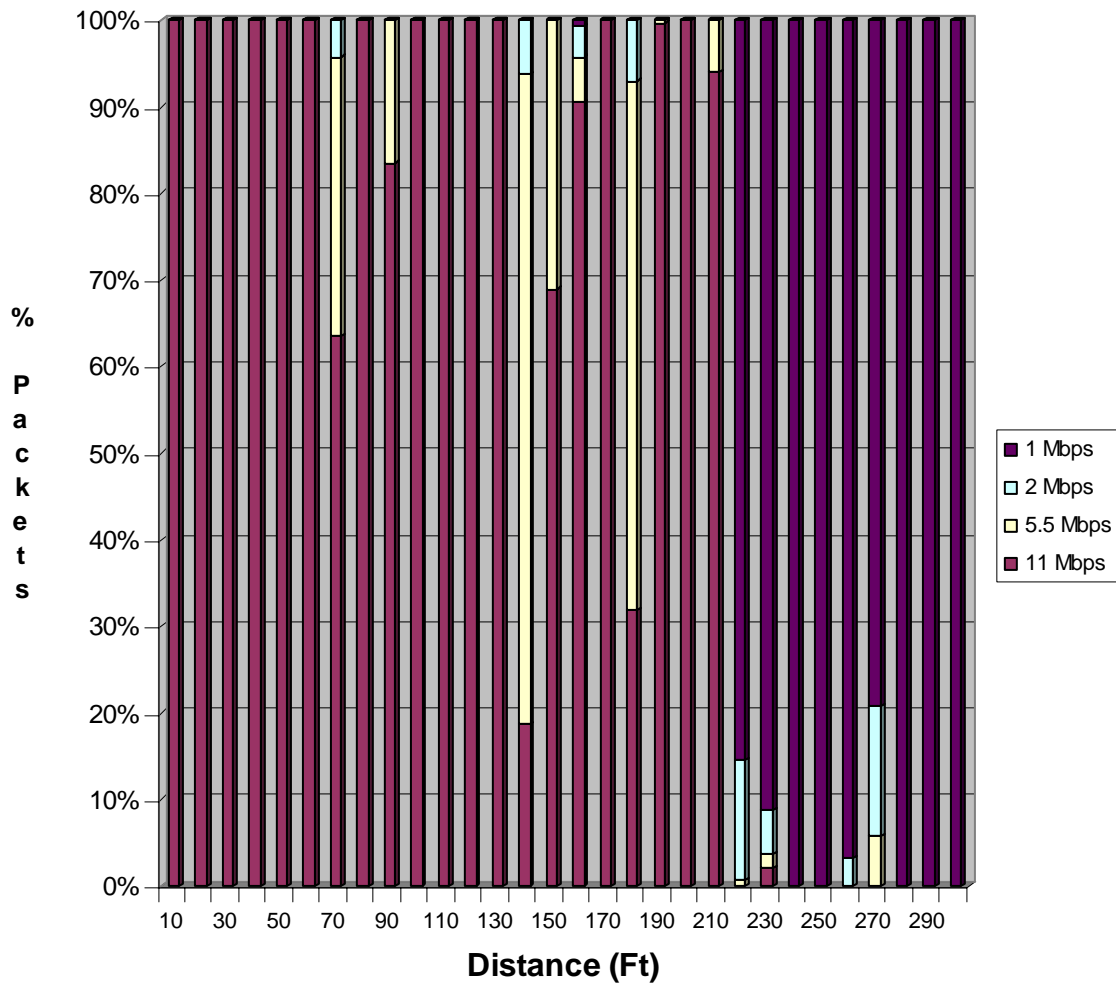
WiFi Average Performance With Distance (EDL-lab1)														
Test	5.1	Average												
Date	4/2/03				Time	1300								
Location					EDL first floor hall & parking lot									
Test Coordinator:					W. Harris									
Test Personnel:					Gary Bastin									
Hardware:					Laptop #BH			Base station:		EDL-lab1				
Address:					00-02-2D-6E-A2-F4			00-50-F2-C7-21-6C						
Encryption (WEP):					128 bit			Firewall:		on	Pings:	Open		
Test Equipment:					Laptop built-in measuring software								Cal:	new
Antenna:					Rear-12:00 (Vertical)									
Distance:					Variable									
				Laptop							Base station			Comments
Run	Dist	Avg	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise		
		Mbps	11	5.5	2	1		dB	dB		dB	dB		
5.1.1	10	11.0	100.0	0.0	0.0	0.0	51.4	-42.4	-93.9	47.3	-50.6	-98.1		
5.1.2	20	11.0	100.0	0.0	0.0	0.0	45.0	-49.9	-94.4	42.3	-55.6	-98.0		
5.1.3	30	11.0	100.0	0.0	0.0	0.0	38.7	-55.6	-93.3	38.1	-60.1	-97.9		
5.1.4	40	11.0	100.0	0.0	0.0	0.0	38.3	-56.1	-94.3	36.1	-62.1	-98.1		
5.1.5	50	11.0	100.0	0.0	0.0	0.0	36.9	-57.9	-94.4	34.3	-63.6	-98.0		
5.1.6	60	11.0	100.0	0.0	0.0	0.0	40.4	-53.6	-94.4	38.6	-59.6	-98.0		
5.1.7	70	8.7	62.6	31.7	4.1	0.0	34.0	-59.6	-94.4	28.3	-69.7	-98.1		
5.1.8	80	11.0	100.0	0.0	0.0	0.0	36.0	-58.1	-94.3	33.1	-64.7	-98.0		
5.1.9	90	10.0	82.7	16.3	0.0	0.0	32.0	-62.7	-95.0	27.6	-70.6	-98.0		
5.1.10	100	11.0	100.0	0.0	0.0	0.0	28.3	-65.6	-93.9	28.3	-69.1	-97.9		
5.1.11	110	11.0	100.0	0.0	0.0	0.0	30.3	-62.4	-93.1	31.4	-66.0	-98.0		
5.1.12	120	11.0	99.6	0.0	0.0	0.0	29.0	-64.0	-93.0	30.7	-67.7	-98.0		
5.1.13	130	11.0	100.0	0.0	0.0	0.0	23.6	-69.9	-93.4	25.9	-72.0	-98.0		
5.1.14	140	6.2	18.5	74.0	6.2	0.0	21.3	-72.5	-93.7	25.5	-72.7	-98.0		
5.1.15	150	9.2	68.3	30.7	0.0	0.0	25.0	-68.1	-92.9	26.4	-70.9	-98.0		
5.1.16	160	10.2	89.3	5.1	3.4	0.7	23.9	-70.0	-93.6	23.7	-73.7	-98.0		
5.1.17	170	11.0	100.0	0.0	0.0	0.0	23.0	-70.3	-93.4	25.1	-72.6	-98.0		
5.1.18	180	6.9	31.3	60.0	6.9	0.0	21.6	-72.7	-94.3	21.1	-76.0	-98.0		
5.1.19	190	10.9	99.0	0.3	0.0	0.0	24.6	-69.1	-94.4	26.4	-70.7	-98.0		
5.1.20	200	11.0	99.6	0.0	0.0	0.0	23.3	-71.4	-95.3	23.9	-73.6	-97.9		
5.1.21	210	10.6	93.1	5.9	0.0	0.0	19.4	-74.7	-94.3	20.3	-77.3	-98.0		
5.1.22	220	1.2	0.0	0.7	13.6	84.4	18.6	-80.7	-95.9	17.4	-83.6	-98.3		
5.1.23	230	1.3	2.0	1.7	5.0	90.0	17.3	-87.7	-96.0	15.3	-90.3	-98.0	drop outs	
5.1.24	240	1.0	0.0	0.0	0.0	100.0	13.0	-102.0	-96.0	16.0	-102.0	-98.0	drop outs	
5.1.25	250	1.0	0.0	0.0	0.0	100.0	15.0	-93.0	-95.7	17.0	-93.3	-98.0	drop outs	
5.1.26	260	1.0	0.0	0.0	3.2	96.4	14.6	-84.8	-93.6	15.6	-87.2	-98.0	drop outs	
5.1.27	270	1.4	0.0	5.7	14.8	78.0	13.7	-93.0	-93.2	15.7	-94.0	-98.7	drop outs	
5.1.28	280	1.0	0.0	0.0	0.0	100.0	13.0	-97.4	-93.4	15.8	-98.8	-99.0	drop outs	
5.1.29	290	1.0	0.0	0.0	0.0	100.0	13.0	-97.0	-94.5	14.8	-97.5	-98.8	drop outs	
5.1.30	300	1.0	0.0	0.0	0.0	100.0	13.0	-102.0	-94.0	13.0	-102.0	-98.5	drop outs	

T-5.1: EDL-lab1 Average SNR With Distance



T-5.1: EDL-lab1 Data Rates With Distance

T-5.1: EDL-lab1 Data Rates



5.2 TEST 5.2: PERFORMANCE VS DISTANCE (EDL-LAB2)

WiFi Performance With Distance (EDL-lab2)

Test	5.2													
Date	4/17/03				Time	0415								
Location					EDL first floor hall & parking lot									
Test Coordinator:					W. Harris									
Test Personnel:					Gary Bastin									
Hardware:					Laptop #BH		Base station: EDL-lab2							
Address:					00-02-2D-6E-A200-0450-F2-C7-C5-6C									
Encryption (WEP):					128 bit		Firewall:		on		Pings:	Open		
Test Equipment:					Laptop built-in measuring software						Cal:	new		
Antenna:					Rear-12:00 (Vertical)									
Distance:					Variable									
			Laptop							Base station			Comments	
Run	Dist	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise		
			11	5.5	2	1		dB	dB		dB	dB		
5.2.1.1	10	0	100	0	0	0	44	-51	-95	49	-52	-101		
5.2.1.2	10	30	100	0	0	0	40	-51	-92	49	-52	-101		
5.2.1.3	10	60	100	0	0	0	43	-49	-93	49	-52	-101		
5.2.1.4	10	90	100	0	0	0	44	-50	-94	48	-53	-101		
5.2.1.5	10	120	100	0	0	0	43	-51	-94	49	-53	-101		
5.2.1.6	10	150	100	0	0	0	45	-50	-94	49	-53	-101		
5.2.1.7	10	180	100	0	0	0	48	-51	-97	49	-53	-101		
Avg			100.0	0.0	0.0	0	43.9	-50.4	-94.1	48.9	-52.6	-101.0		
Median			100.0	0.0	0.0	0	44.0	-51.0	-94.0	49.0	-53.0	-101.0		
Std Dev			0.0	0.0	0.0	0	2.4	0.8	1.6	0.4	0.5	0.0		
Mode			100.0	0.0	0.0	0	44.0	-51.0	-94.0	49.0	-53.0	-101.0		
5.2.2.1	20	0	100	0	0	0	44	-50	-95	47	-55	-102		
5.2.2.2	20	30	100	0	0	0	45	-50	-93	47	-54	-102		
5.2.2.3	20	60	100	0	0	0	46	-50	-95	47	-55	-102		
5.2.2.4	20	90	100	0	0	0	44	-51	-95	45	-56	-102		
5.2.2.5	20	120	100	0	0	0	44	-49	-94	48	-54	-102		
5.2.2.6	20	150	100	0	0	0	46	-50	-96	47	-55	-101		
5.2.2.7	20	180	100	0	0	0	42	-51	-94	46	-55	-101		
Avg			100.0	0.0	0.0	0	44.4	-50.1	-94.6	46.7	-54.9	-101.7		
Median			100.0	0.0	0.0	0	44.0	-50.0	-95.0	47.0	-55.0	-102.0		
Std Dev			0.0	0.0	0.0	0	1.4	0.7	1.0	1.0	0.7	0.5		
Mode			100.0	0.0	0.0	0	44.0	-50.0	-95.0	47.0	-55.0	-102.0		
5.2.3.1	30	0	100	0	0	0	46	-47	-94	50	-52	-102		
5.2.3.2	30	30	100	0	0	0	48	-47	-95	50	-52	-102		
5.2.3.3	30	60	100	0	0	0	46	-47	-92	49	-52	-102		
5.2.3.4	30	90	100	0	0	0	47	-47	-93	49	-52	-102		
5.2.3.5	30	120	100	0	0	0	47	-47	-95	49	-52	-101		
5.2.3.6	30	150	100	0	0	0	48	-47	-95	49	-52	-101		
5.2.3.7	30	180	100	0	0	0	51	-47	-97	49	-52	-101		
Avg			100.0	0.0	0.0	0	47.6	-47.0	-94.4	49.3	-52.0	-101.6		
Median			100.0	0.0	0.0	0	47.0	-47.0	-95.0	49.0	-52.0	-102.0		
Std Dev			0.0	0.0	0.0	0	1.7	0.0	1.6	0.5	0.0	0.5		
Mode			100.0	0.0	0.0	0	46.0	-47.0	-95.0	49.0	-52.0	-102.0		

5.2.4.1	40	0	100	0	0	0	45	-53	-97	46	-56	-102	
5.2.4.2	40	30	100	0	0	0	44	-54	-98	45	-57	-102	
5.2.4.3	40	60	100	0	0	0	43	-53	-96	46	-57	-101	
5.2.4.4	40	90	100	0	0	0	42	-54	-96	45	-57	-101	
5.2.4.5	40	120	100	0	0	0	43	-52	-95	45	-58	-101	
5.2.4.6	40	150	100	0	0	0	42	-53	-96	45	-57	-101	
5.2.4.7	40	180	100	0	0	0	40	-54	-94	45	-57	-101	
Avg			100.0	0.0	0.0	0	42.7	-53.3	-96.0	45.3	-57.0	-101.3	
Median			100.0	0.0	0.0	0	43.0	-53.0	-96.0	45.0	-57.0	-101.0	
Std Dev			0.0	0.0	0.0	0	1.6	0.8	1.3	0.5	0.6	0.5	
Mode			100.0	0.0	0.0	0	43.0	-53.0	-96.0	45.0	-57.0	-101.0	
5.2.5.1	50	0	100	0	0	0	43	-54	-97	45	-56	-102	
5.2.5.2	50	30	100	0	0	0	41	-54	-94	44	-58	-102	
5.2.5.3	50	60	100	0	0	0	41	-53	-95	45	-58	-101	
5.2.5.4	50	90	100	0	0	0	39	-53	-93	44	-57	-101	
5.2.5.5	50	120	100	0	0	0	40	-53	-94	43	-57	-101	
5.2.5.6	50	150	100	0	0	0	42	-54	-95	45	-56	-101	
5.2.5.7	50	180	100	0	0	0	40	-54	-93	45	-56	-101	
Avg			100.0	0.0	0.0	0	40.9	-53.6	-94.4	44.4	-56.9	-101.3	
Median			100.0	0.0	0.0	0	41.0	-54.0	-94.0	45.0	-57.0	-101.0	
Std Dev			0.0	0.0	0.0	0	1.3	0.5	1.4	0.8	0.9	0.5	
Mode			100.0	0.0	0.0	0	41.0	-54.0	-94.0	45.0	-56.0	-101.0	
5.2.6.1	60	0	100	0	0	0	29	-63	-91	33	-70	-102	
5.2.6.2	60	30	100	0	0	0	33	-64	-96	32	-69	-102	
5.2.6.3	60	60	100	0	0	0	30	-64	-93	31	-70	-102	
5.2.6.4	60	90	100	0	0	0	31	-65	-95	33	-70	-102	
5.2.6.5	60	120	100	0	0	0	29	-64	-93	32	-69	-102	
5.2.6.6	60	150	100	0	0	0	34	-63	-97	33	-69	-102	
5.2.6.7	60	180	100	0	0	0	30	-64	-94	32	-70	-102	
Avg			100.0	0.0	0.0	0	30.9	-63.9	-94.1	32.3	-69.6	-102.0	
Median			100.0	0.0	0.0	0	30.0	-64.0	-94.0	32.0	-70.0	-102.0	
Std Dev			0.0	0.0	0.0	0	2.0	0.7	2.0	0.8	0.5	0.0	
Mode			100.0	0.0	0.0	0	29.0	-64.0	-93.0	33.0	-70.0	-102.0	
5.2.7.1	70	0	100	0	0	0	28	-65	-92	38	-65	-102	
5.2.7.2	70	30	100	0	0	0	31	-64	-95	37	-66	-102	
5.2.7.3	70	60	100	0	0	0	29	-65	-94	37	-65	-102	
5.2.7.4	70	90	100	0	0	0	28	-65	-93	37	-66	-102	
5.2.7.5	70	120	100	0	0	0	32	-65	-97	37	-66	-102	
5.2.7.6	70	150	100	0	0	0	26	-67	-93	36	-66	-102	
5.2.7.7	70	180	100	0	0	0	30	-65	-94	37	-66	-102	
Avg			100.0	0.0	0.0	0	29.1	-65.1	-94.0	37.0	-65.7	-102.0	
Median			100.0	0.0	0.0	0	29.0	-65.0	-94.0	37.0	-66.0	-102.0	
Std Dev			0.0	0.0	0.0	0	2.0	0.9	1.6	0.6	0.5	0.0	
Mode			100.0	0.0	0.0	0	28.0	-65.0	-94.0	37.0	-66.0	-102.0	

ECT Phase 2 – Vol. 2 – Appendices

5.2.8.1	80	0	100	0	0	0	31	-65	-96	31	-70	-102	
5.2.8.2	80	30	100	0	0	0	32	-64	-97	32	-70	-102	
5.2.8.3	80	60	100	0	0	0	28	-66	-94	30	-71	-102	
5.2.8.4	80	90	100	0	0	0	29	-65	-95	31	-70	-102	
5.2.8.5	80	120	100	0	0	0	31	-65	-97	32	-69	-102	
5.2.8.6	80	150	100	0	0	0	29	-65	-94	32	-71	-102	
5.2.8.7	80	180	100	0	0	0	33	-64	-96	31	-70	-102	
Avg			100.0	0.0	0.0	0	30.4	-64.9	-95.6	31.3	-70.1	-102.0	
Median			100.0	0.0	0.0	0	31.0	-65.0	-96.0	31.0	-70.0	-102.0	
Std Dev			0.0	0.0	0.0	0	1.8	0.7	1.3	0.8	0.7	0.0	
Mode			100.0	0.0	0.0	0	31.0	-65.0	-96.0	31.0	-70.0	-102.0	
5.2.9.1	90	0	100	0	0	0	31	-64	-96	35	-68	-102	
5.2.9.2	90	30	100	0	0	0	27	-66	-93	33	-70	-102	
5.2.9.3	90	60	100	0	0	0	26	-65	-92	33	-68	-102	
5.2.9.4	90	90	100	0	0	0	31	-65	-96	33	-68	-102	
5.2.9.5	90	120	100	0	0	0	29	-66	-95	33	-69	-102	
5.2.9.6	90	150	100	0	0	0	30	-66	-95	33	-68	-102	
5.2.9.7	90	180	100	0	0	0	28	-66	-94	33	-69	-102	
Avg			100.0	0.0	0.0	0	28.9	-65.4	-94.4	33.3	-68.6	-102.0	
Median			100.0	0.0	0.0	0	29.0	-66.0	-95.0	33.0	-68.0	-102.0	
Std Dev			0.0	0.0	0.0	0	2.0	0.8	1.5	0.8	0.8	0.0	
Mode			100.0	0.0	0.0	0	31.0	-66.0	-96.0	33.0	-68.0	-102.0	
5.2.10.1	100	0	100	0	0	0	30	-65	-94	32	-69	-102	
5.2.10.2	100	30	96	3	0	0	29	-65	-94	32	-70	-102	
5.2.10.3	100	60	97	2	0	0	29	-65	-95	28	-75	-102	
5.2.10.4	100	90	97	2	0	0	29	-65	-96	30	-73	-102	
5.2.10.5	100	120	97	2	0	0	31	-68	-98	30	-73	-102	
5.2.10.6	100	150	97	2	0	0	30	-67	-96	31	-72	-102	
5.2.10.7	100	180	97	2	0	0	28	-66	-95	31	-72	-102	
Avg			97.3	1.9	0	0	29.4	-65.9	-95.4	30.6	-72.0	-102.0	
Median			97.0	2.0	0	0	29.0	-65.0	-95.0	31.0	-72.0	-102.0	
Std Dev			1.3	0.9	0	0	1.0	1.2	1.4	1.4	2.0	0.0	
Mode			97.0	2.0	0	0	29.0	-65.0	-94.0	32.0	-73.0	-102.0	
5.2.11.1	110	0	100	0	0	0	26	-68	-94	30	-72	-102	
5.2.11.2	110	30	100	0	0	0	26	-68	-94	31	-72	-102	
5.2.11.3	110	60	100	0	0	0	24	-68	-92	30	-72	-102	
5.2.11.4	110	90	100	0	0	0	24	-67	-92	28	-73	-102	
5.2.11.5	110	120	100	0	0	0	25	-71	-95	29	-76	-102	
5.2.11.6	110	150	100	0	0	0	27	-68	-95	29	-72	-102	
5.2.11.7	110	180	100	0	0	0	26	-68	-93	29	-73	-102	
Avg			100.0	0.0	0	0	25.4	-68.3	-93.6	29.4	-72.9	-102.0	
Median			100.0	0.0	0	0	26.0	-68.0	-94.0	29.0	-72.0	-102.0	
Std Dev			0.0	0.0	0	0	1.1	1.3	1.3	1.0	1.5	0.0	
Mode			100.0	0.0	0	0	26.0	-68.0	-94.0	29.0	-72.0	-102.0	

ECT Phase 2 – Vol. 2 – Appendices

5.2.12.1	120	0	100	0	0	0	28	-68	-96	31	-71	-102	
5.2.12.2	120	30	100	0	0	0	27	-66	-94	32	-70	-102	
5.2.12.3	120	60	100	0	0	0	28	-68	-95	31	-70	-102	
5.2.12.4	120	90	100	0	0	0	32	-65	-96	33	-68	-102	
5.2.12.5	120	120	100	0	0	0	27	-67	-95	32	-70	-102	
5.2.12.6	120	150	100	0	0	0	29	-67	-95	31	-70	-102	
5.2.12.7	120	180	100	0	0	0	26	-67	-92	32	-69	-102	
Avg			100.0	0.0	0	0	28.1	-66.9	-94.7	31.7	-69.7	-102.0	
Median			100.0	0.0	0	0	28.0	-67.0	-95.0	32.0	-70.0	-102.0	
Std Dev			0.0	0.0	0	0	2.0	1.1	1.4	0.8	1.0	0.0	
Mode			100.0	0.0	0	0	28.0	-67.0	-95.0	31.0	-70.0	-102.0	
5.2.13.1	130	0	100	0	0	0	27	-70	-96	29	-73	-102	
5.2.13.2	130	30	100	0	0	0	30	-67	-97	31	-71	-102	
5.2.13.3	130	60	100	0	0	0	28	-68	-94	32	-70	-102	
5.2.13.4	130	90	100	0	0	0	25	-67	-93	33	-70	-102	
5.2.13.5	130	120	100	0	0	0	26	-67	-93	33	-70	-102	
5.2.13.6	130	150	100	0	0	0	26	-67	-93	31	-71	-102	
5.2.13.7	130	180	100	0	0	0	28	-67	-94	33	-70	-102	
Avg			100.0	0.0	0	0	27.1	-67.6	-94.3	31.7	-70.7	-102.0	
Median			100.0	0.0	0	0	27.0	-67.0	-94.0	32.0	-70.0	-102.0	
Std Dev			0.0	0.0	0	0	1.7	1.1	1.6	1.5	1.1	0.0	
Mode			100.0	0.0	0	0	28.0	-67.0	-93.0	33.0	-70.0	-102.0	
5.2.14.1	140	0	100	0	0	0	25	-68	-93	28	-74	-102	
5.2.14.2	140	30	100	0	0	0	26	-69	-95	29	-73	-102	
5.2.14.3	140	60	100	0	0	0	25	-68	-92	29	-73	-102	
5.2.14.4	140	90	100	0	0	0	29	-68	-95	30	-72	-102	
5.2.14.5	140	120	100	0	0	0	25	-68	-93	31	-72	-102	
5.2.14.6	140	150	100	0	0	0	24	-68	-93	30	-73	-102	
5.2.14.7	140	180	100	0	0	0	28	-68	-95	30	-72	-102	
Avg			100.0	0.0	0	0	26.0	-68.1	-93.7	29.6	-72.7	-102.0	
Median			100.0	0.0	0	0	25.0	-68.0	-93.0	30.0	-73.0	-102.0	
Std Dev			0.0	0.0	0	0	1.8	0.4	1.3	1.0	0.8	0.0	
Mode			100.0	0.0	0	0	25.0	-68.0	-93.0	30.0	-73.0	-102.0	
5.2.15.1	150	0	100	0	0	0	28	-67	-95	30	-72	-102	
5.2.15.2	150	30	100	0	0	0	27	-67	-95	32	-69	-102	
5.2.15.3	150	60	100	0	0	0	26	-67	-94	30	-72	-102	
5.2.15.4	150	90	100	0	0	0	26	-68	-94	31	-71	-102	
5.2.15.5	150	120	100	0	0	0	27	-68	-95	31	-72	-102	
5.2.15.6	150	150	100	0	0	0	27	-68	-94	30	-71	-102	
5.2.15.7	150	180	100	0	0	0	24	-67	-91	32	-70	-102	
Avg			100.0	0.0	0	0	26.4	-67.4	-94.0	30.9	-71.0	-102.0	
Median			100.0	0.0	0	0	27.0	-67.0	-94.0	31.0	-71.0	-102.0	
Std Dev			0.0	0.0	0	0	1.3	0.5	1.4	0.9	1.2	0.0	
Mode			100.0	0.0	0	0	27.0	-67.0	-95.0	30.0	-72.0	-102.0	

ECT Phase 2 – Vol. 2 – Appendices

5.2.16.1	160	0	100	0	0	0	22	-70	-92	23	-79	-102	
5.2.16.2	160	30	88	11	0	0	21	-72	-93	25	-78	-102	
5.2.16.3	160	60	87	10	0	0	22	-72	-94	25	-78	-102	
5.2.16.4	160	90	92	7	0	0	24	-71	-95	25	-77	-102	
5.2.16.5	160	120	88	11	0	0	24	-70	-93	26	-77	-102	
5.2.16.6	160	150	87	11	1	0	20	-74	-94	21	-82	-102	
5.2.16.7	160	180	86	12	1	0	24	-72	-94	27	-76	-102	
Avg			89.7	8.9	0.3	0	22.4	-71.6	-93.6	24.6	-78.1	-102.0	
Median			88.0	11.0	0.0	0	22.0	-72.0	-94.0	25.0	-78.0	-102.0	
Std Dev			4.9	4.2	0.5	0	1.6	1.4	1.0	2.0	2.0	0.0	
Mode			88.0	11.0	0.0	0	24.0	-72.0	-94.0	25.0	-78.0	-102.0	
5.2.17.1	170	170	100	0	0	0	25	-70	-95	28	-74	-102	
5.2.17.2	170	30	100	0	0	0	24	-70	-94	27	-75	-102	
5.2.17.3	170	60	100	0	0	0	24	-70	-92	29	-74	-102	
5.2.17.4	170	90	100	0	0	0	24	-70	-93	27	-75	-102	
5.2.17.5	170	120	100	0	0	0	27	-69	-95	29	-74	-102	
5.2.17.6	170	150	100	0	0	0	25	-70	-94	27	-75	-102	
5.2.17.7	170	180	100	0	0	0	23	-71	-93	27	-75	-102	
Avg			100.0	0.0	0.0	0	24.6	-70.0	-93.7	27.7	-74.6	-102.0	
Median			100.0	0.0	0.0	0	24.0	-70.0	-94.0	27.0	-75.0	-102.0	
Std Dev			0.0	0.0	0.0	0	1.3	0.6	1.1	1.0	0.5	0.0	
Mode			100.0	0.0	0.0	0	24.0	-70.0	-95.0	27.0	-75.0	-102.0	
5.2.18.1	180	180	100	0	0	0	21	-69	-91	33	-69	-102	
5.2.18.2	180	30	100	0	0	0	25	-69	-94	33	-69	-102	
5.2.18.3	180	60	100	0	0	0	28	-69	-96	33	-68	-102	
5.2.18.4	180	90	100	0	0	0	24	-69	-94	33	-68	-102	
5.2.18.5	180	120	100	0	0	0	26	-69	-93	33	-68	-102	
5.2.18.6	180	150	100	0	0	0	26	-69	-95	33	-68	-102	
5.2.18.7	180	180	100	0	0	0	26	-68	-94	33	-68	-102	
Avg			100.0	0.0	0.0	0	25.14	-68.86	-93.86	33	-68.29	-102	
Median			100.0	0.0	0.0	0	26.0	-69.0	-94.0	33.0	-68.0	-102.0	
Std Dev			0.0	0.0	0.0	0	2.2	0.4	1.6	0.0	0.5	0.0	
Mode			100.0	0.0	0.0	0	26.0	-69.0	-94.0	33.0	-68.0	-102.0	
5.2.19.1	190	190	100	0	0	0	24	-67	-92	31	-71	-102	
5.2.19.2	190	30	100	0	0	0	28	-68	-94	32	-70	-102	
5.2.19.3	190	60	100	0	0	0	28	-68	-94	31	-71	-102	
5.2.19.4	190	90	100	0	0	0	26	-68	-94	31	-71	-102	
5.2.19.5	190	120	100	0	0	0	25	-67	-92	31	-71	-102	
5.2.19.6	190	150	100	0	0	0	26	-68	-94	31	-72	-102	
5.2.19.7	190	180	100	0	0	0	27	-68	-94	31	-70	-102	
Avg			100.0	0.0	0.0	0	26.29	-67.71	-93.43	31.14	-70.86	-102	
Median			100.0	0.0	0.0	0	26.0	-68.0	-94.0	31.0	-71.0	-102.0	
Std Dev			0.0	0.0	0.0	0	1.5	0.5	1.0	0.4	0.7	0.0	
Mode			100.0	0.0	0.0	0	28.0	-68.0	-94.0	31.0	-71.0	-102.0	

ECT Phase 2 – Vol. 2 – Appendices

5.2.20.1	200	200	85	14	0	0	20	-73	-93	22	-79	-102	
5.2.20.2	200	30	91	8	0	0	20	-72	-92	23	-78	-102	
5.2.20.3	200	60	95	4	0	0	21	-71	-92	24	-79	-102	
5.2.20.4	200	90	97	2	0	0	22	-71	-93	25	-78	-102	
5.2.20.5	200	120	97	2	0	0	21	-72	-94	22	-79	-102	
5.2.20.6	200	150	98	1	0	0	22	-72	-93	24	-78	-102	
5.2.20.7	200	180	98	1	0	0	24	-72	-95	23	-78	-102	
Avg			94.4	4.6	0.0	0	21.4	-71.9	-93.1	23.3	-78.4	-102.0	
Median			97.0	2.0	0.0	0	21.0	-72.0	-93.0	23.0	-78.0	-102.0	
Std Dev			4.8	4.8	0.0	0	1.4	0.7	1.1	1.1	0.5	0.0	
Mode			97.0	2.0	0.0	0	20.0	-72.0	-93.0	22.0	-78.0	-102.0	
5.2.21.1	210	210	100	0	0	0	25	-72	-97	27	-75	-102	
5.2.21.2	210	30	100	0	0	0	22	-72	-94	27	-74	-102	
5.2.21.3	210	60	100	0	0	0	22	-73	-95	25	-77	-102	
5.2.21.4	210	90	100	0	0	0	22	-72	-95	26	-77	-102	
5.2.21.5	210	120	100	0	0	0	23	-72	-94	25	-77	-102	
5.2.21.6	210	150	100	0	0	0	21	-72	-93	26	-76	-102	
5.2.21.7	210	180	100	0	0	0	22	-71	-94	27	-74	-102	
Avg			100.0	0.0	0.0	0	22.4	-72.0	-94.6	26.1	-75.7	-102.0	
Median			100.0	0.0	0.0	0	22.0	-72.0	-94.0	26.0	-76.0	-102.0	
Std Dev			0.0	0.0	0.0	0	1.3	0.6	1.3	0.9	1.4	0.0	
Mode			100.0	0.0	0.0	0	22.0	-72.0	-94.0	27.0	-77.0	-102.0	
5.2.22.1	220	220	39	55	4	0	15	-76	-91	23	-80	-102	
5.2.22.2	220	30	46	51	2	0	16	-76	-92	23	-80	-102	
5.2.22.3	220	60	39	59	1	0	21	-76	-96	23	-78	-102	
5.2.22.4	220	90	44	54	1	0	19	-74	-93	24	-78	-102	
5.2.22.5	220	120	50	48	0	0	19	-75	-95	23	-79	-102	
5.2.22.6	220	150	50	48	0	0	18	-77	-96	23	-80	-102	
5.2.22.7	220	180	55	43	0	0	16	-77	-94	22	-79	-102	
Avg			46.1	51.1	1.1	0	17.7	-75.9	-93.9	23.0	-79.1	-102.0	
Median			46.0	51.0	1.0	0	18.0	-76.0	-94.0	23.0	-79.0	-102.0	
Std Dev			6.0	5.3	1.5	0	2.1	1.1	2.0	0.6	0.9	0.0	
Mode			39.0	48.0	0.0	0	16.0	-76.0	-96.0	23.0	-80.0	-102.0	
5.2.23.1	230	230	47	52	0	0	17	-75	-93	20	-82	-102	
5.2.23.2	230	30	30	69	0	0	19	-75	-95	19	-83	-102	
5.2.23.3	230	60	23	71	4	0	19	-75	-94	20	-82	-102	
5.2.23.4	230	90	21	69	7	1	19	-76	-95	19	-83	-102	
5.2.23.5	230	120	18	69	9	2	18	-77	-96	19	-83	-102	
5.2.23.6	230	150	20	68	9	1	18	-76	-93	19	-83	-102	
5.2.23.7	230	180	21	66	9	2	19	-77	-93	19	-83	-102	

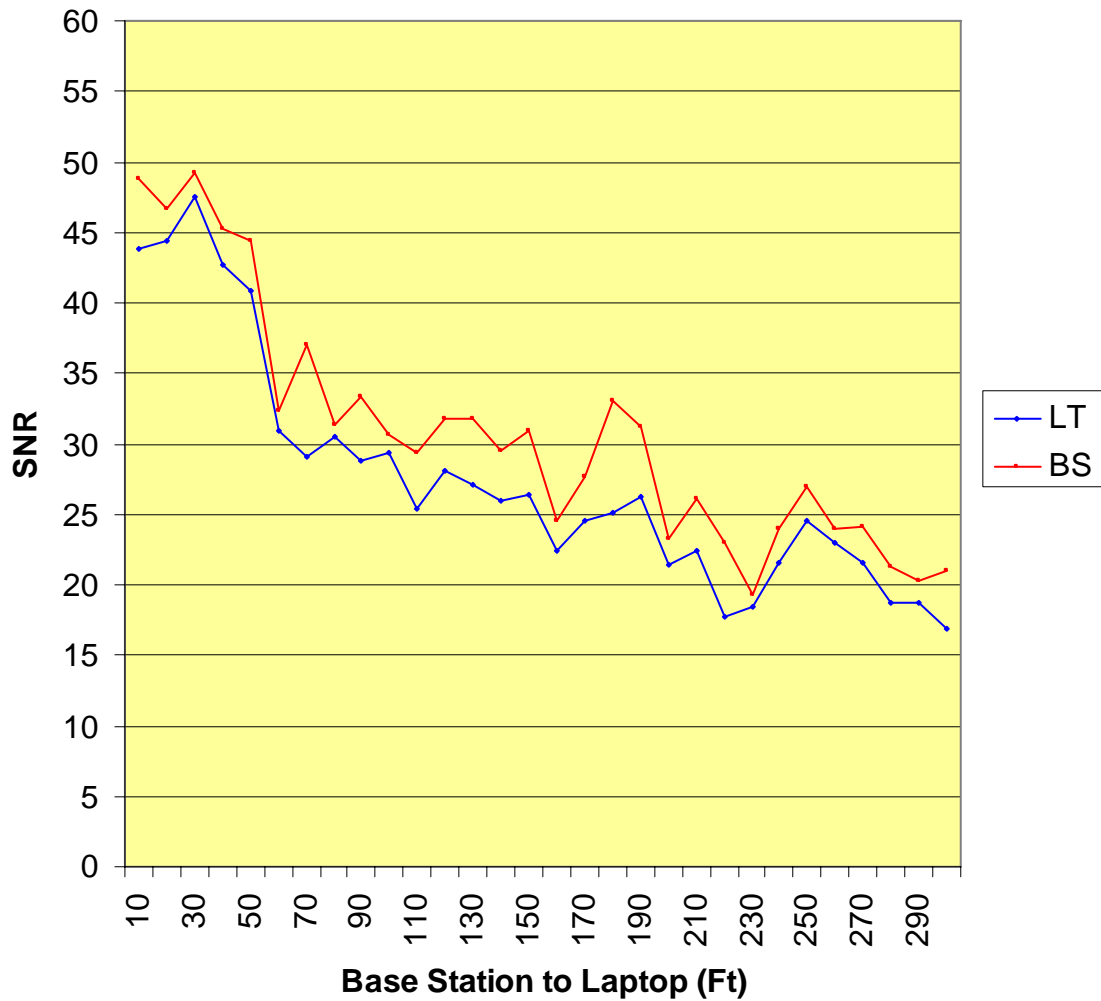
ECT Phase 2 – Vol. 2 – Appendices

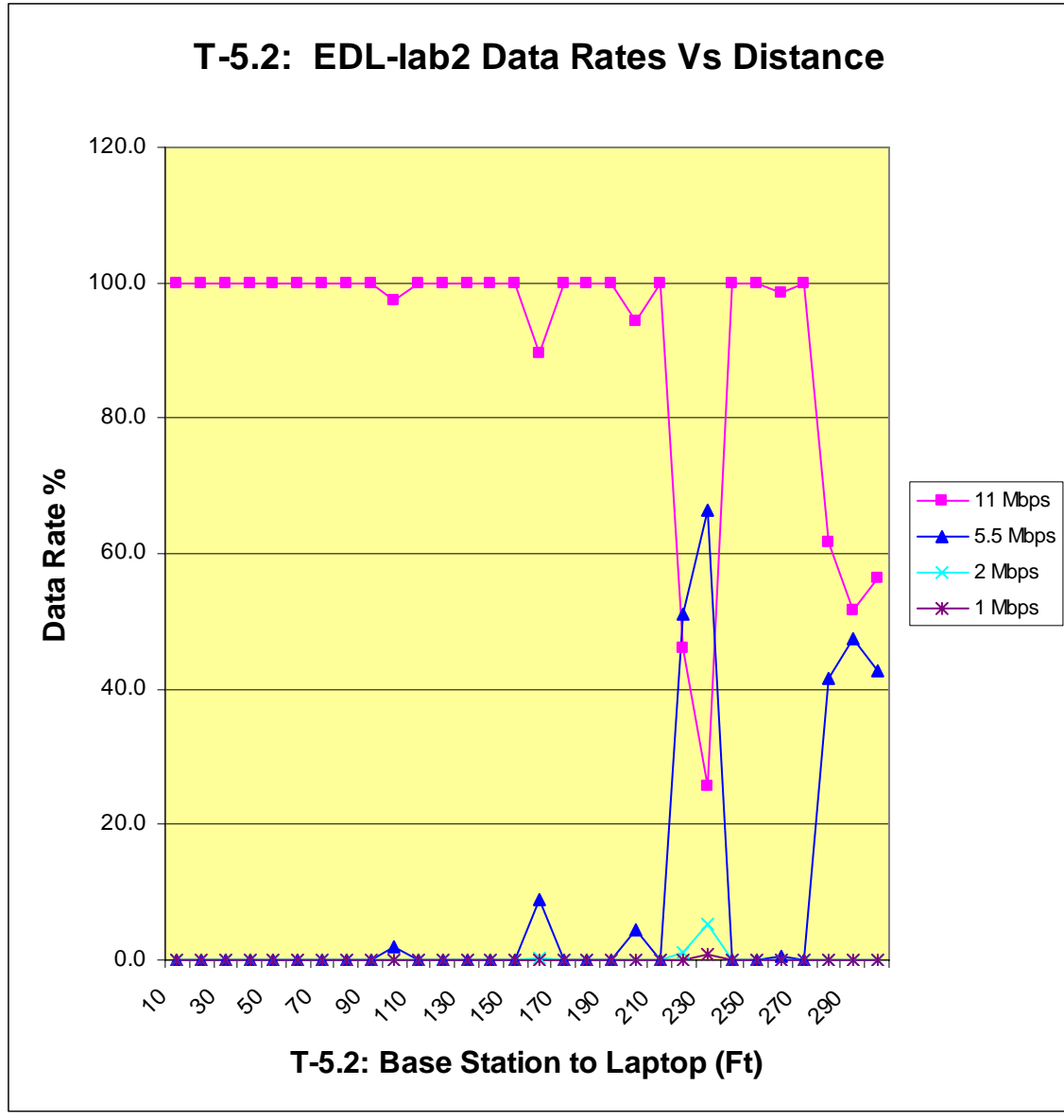
5.2.24.1	240	240	100	0	0	0	23	-72	-95	24	-78	-102	
5.2.24.2	240	30	100	0	0	0	23	-72	-94	24	-77	-102	
5.2.24.3	240	60	100	0	0	0	23	-72	-95	24	-77	-102	
5.2.24.4	240	90	100	0	0	0	20	-72	-92	25	-77	-102	
5.2.24.5	240	120	100	0	0	0	22	-72	-94	24	-77	-102	
5.2.24.6	240	150	100	0	0	0	21	-72	-94	24	-79	-102	
5.2.24.7	240	180	100	0	0	0	19	-72	-91	23	-79	-102	
Avg			100.0	0.0	0.0	0	21.6	-72.0	-93.6	24.0	-77.7	-102.0	
Median			100.0	0.0	0.0	0	22.0	-72.0	-94.0	24.0	-77.0	-102.0	
Std Dev			0.0	0.0	0.0	0	1.6	0.0	1.5	0.6	1.0	0.0	
Mode			100.0	0.0	0.0	0	23.0	-72.0	-94.0	24.0	-77.0	-102.0	
5.2.25.1	250	250	100	0	0	0	25	-70	-93	27	-75	-102	
5.2.25.2	250	30	100	0	0	0	25	-70	-95	27	-75	-102	
5.2.25.3	250	60	100	0	0	0	23	-70	-94	28	-75	-102	
5.2.25.4	250	90	100	0	0	0	25	-70	-95	27	-74	-102	
5.2.25.5	250	120	100	0	0	0	23	-70	-93	27	-74	-102	
5.2.25.6	250	150	100	0	0	0	27	-70	-96	26	-75	-102	
5.2.25.7	250	180	100	0	0	0	24	-70	-94	27	-75	-102	
Avg			100.0	0.0	0.0	0	24.6	-70.0	-94.3	27.0	-74.7	-102.0	
Median			100.0	0.0	0.0	0	25.0	-70.0	-94.0	27.0	-75.0	-102.0	
Std Dev			0.0	0.0	0.0	0	1.4	0.0	1.1	0.6	0.5	0.0	
Mode			100.0	0.0	0.0	0	25.0	-70.0	-93.0	27.0	-75.0	-102.0	
5.2.26.1	260	260	100	0	0	0	24	-71	-96	24	-78	-102	
5.2.26.2	260	30	97	2	0	0	23	-71	-95	24	-78	-102	
5.2.26.3	260	60	98	1	0	0	24	-72	-97	24	-78	-102	
5.2.26.4	260	90	98	1	0	0	23	-72	-94	24	-78	-102	
5.2.26.5	260	120	99	0	0	0	24	-72	-96	24	-79	-102	
5.2.26.6	260	150	99	0	0	0	24	-72	-96	24	-78	-102	
5.2.26.7	260	180	99	0	0	0	19	-72	-92	24	-79	-102	
Avg			98.6	0.6	0.0	0	23.0	-71.7	-95.1	24.0	-78.3	-102.0	
Median			99.0	0.0	0.0	0	24.0	-72.0	-96.0	24.0	-78.0	-102.0	
Std Dev			1.0	0.8	0.0	0	1.8	0.5	1.7	0.0	0.5	0.0	
Mode			99.0	0.0	0.0	0	24.0	-72.0	-96.0	24.0	-78.0	-102.0	
5.2.27.1	270	270	100	0	0	0	22	-73	-95	24	-77	-102	
5.2.27.2	270	30	100	0	0	0	21	-73	-93	25	-78	-102	
5.2.27.3	270	60	100	0	0	0	22	-73	-95	24	-78	-102	
5.2.27.4	270	90	100	0	0	0	22	-73	-95	24	-78	-102	
5.2.27.5	270	120	100	0	0	0	22	-73	-94	24	-78	-102	
5.2.27.6	270	150	100	0	0	0	21	-73	-93	24	-77	-102	
5.2.27.7	270	180	100	0	0	0	21	-73	-93	24	-78	-102	
Avg			100.0	0.0	0.0	0	21.6	-73.0	-94.0	24.1	-77.7	-102.0	
Median			100.0	0.0	0.0	0	22.0	-73.0	-94.0	24.0	-78.0	-102.0	
Std Dev			0.0	0.0	0.0	0	0.5	0.0	1.0	0.4	0.5	0.0	
Mode			100.0	0.0	0.0	0	22.0	-73.0	-95.0	24.0	-78.0	-102.0	

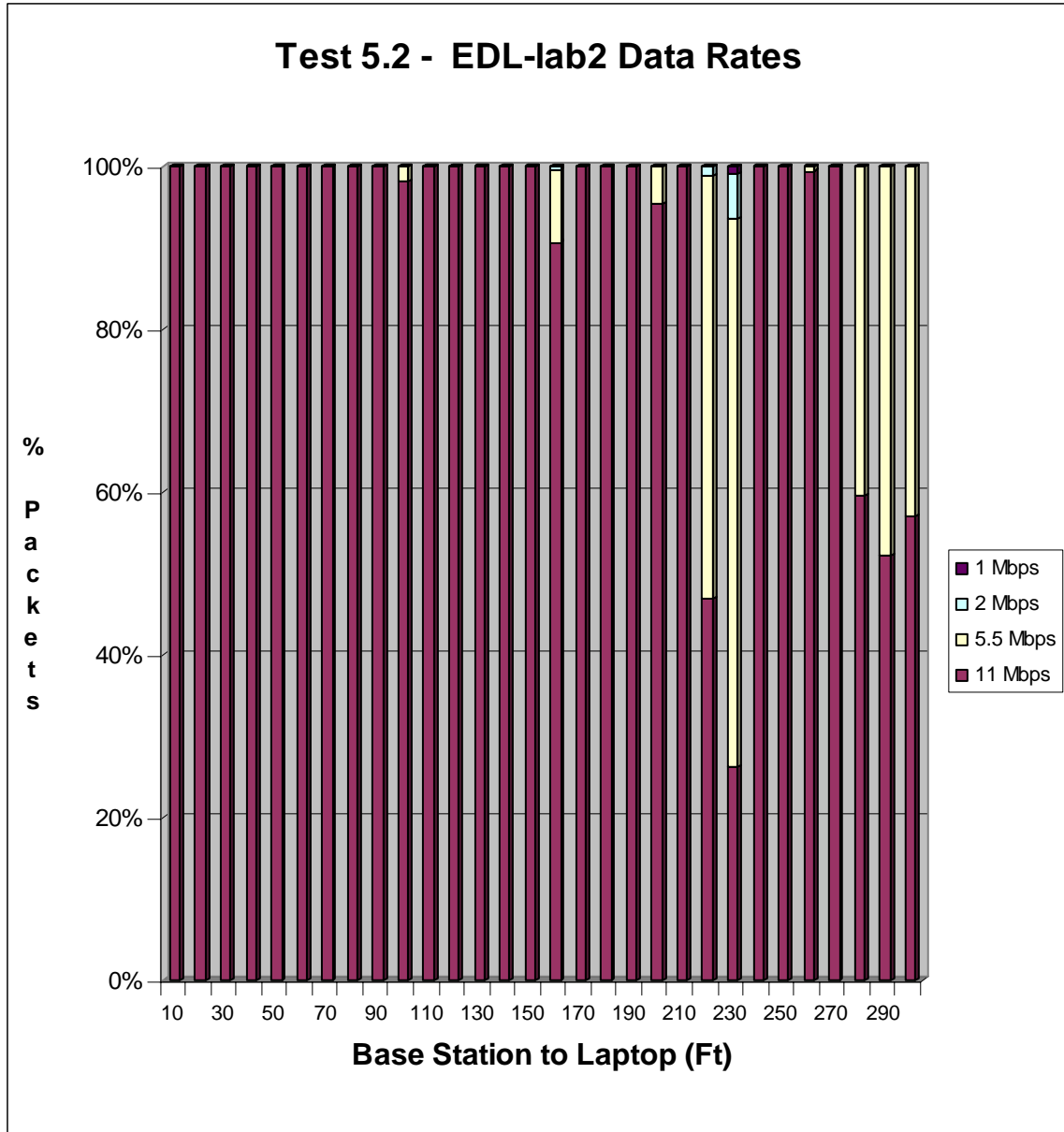
ECT Phase 2 – Vol. 2 – Appendices

5.2.28.1	280	280	91	38	0	0	19	-76	-95	21	-80	-102	
5.2.28.2	280	30	48	51	0	0	19	-76	-95	21	-81	-102	
5.2.28.3	280	60	52	47	0	0	17	-76	-93	21	-80	-102	
5.2.28.4	280	90	58	41	0	0	21	-76	-97	21	-81	-102	
5.2.28.5	280	120	57	42	0	0	18	-76	-93	21	-81	-102	
5.2.28.6	280	150	62	37	0	0	19	-76	-94	22	-80	-102	
5.2.28.7	280	180	63	36	0	0	18	-76	-94	22	-80	-102	
Avg			61.6	41.7	0.0	0	18.7	-76.0	-94.4	21.3	-80.4	-102.0	
Median			58.0	41.0	0.0	0	19.0	-76.0	-94.0	21.0	-80.0	-102.0	
Std Dev			14.0	5.5	0.0	0	1.3	0.0	1.4	0.5	0.5	0.0	
Mode			#N/A	#N/A	0.0	0	19.0	-76.0	-95.0	21.0	-80.0	-102.0	
5.2.29.1	290	290	94	5	0	0	22	-77	-98	21	-82	-102	
5.2.29.2	290	30	64	35	0	0	19	-77	-96	21	-82	-102	
5.2.29.3	290	60	50	50	0	0	16	-77	-93	20	-82	-102	
5.2.29.4	290	90	44	55	0	0	19	-78	-96	19	-82	-102	
5.2.29.5	290	120	39	60	0	0	19	-78	-96	20	-82	-102	
5.2.29.6	290	150	36	63	0	0	18	-78	-96	20	-82	-102	
5.2.29.7	290	180	35	64	0	0	18	-78	-94	21	-81	-102	
Avg			51.7	47.4	0.0	0	18.7	-77.6	-95.6	20.3	-81.9	-102.0	
Median			44.0	55.0	0.0	0	19.0	-78.0	-96.0	20.0	-82.0	-102.0	
Std Dev			21.2	21.2	0.0	0	1.8	0.5	1.6	0.8	0.4	0.0	
Mode			#N/A	#N/A	0.0	0	19.0	-78.0	-96.0	21.0	-82.0	-102.0	
5.2.30.1	300	300	84	15	0	0	15	-76	-93	21	-81	-102	
5.2.30.2	300	30	50	49	0	0	15	-76	-92	21	-81	-102	
5.2.30.3	300	60	50	49	0	0	17	-76	-94	21	-80	-102	
5.2.30.4	300	90	50	49	0	0	17	-76	-92	21	-81	-102	
5.2.30.5	300	120	52	47	0	0	17	-76	-93	21	-80	-102	
5.2.30.6	300	150	54	45	0	0	18	-77	-95	21	-80	-102	
5.2.30.7	300	180	55	44	0	0	19	-76	-95	21	-80	-102	
Avg			56.4	42.6	0.0	0	16.9	-76.1	-93.4	21.0	-80.4	-102.0	
Median			52.0	47.0	0.0	0	17.0	-76.0	-93.0	21.0	-80.0	-102.0	
Std Dev			12.3	12.3	0.0	0	1.5	0.4	1.3	0.0	0.5	0.0	
Mode			50.0	49.0	0.0	0	17.0	-76.0	-93.0	21.0	-80.0	-102.0	

WiFi Average Performance With Distance (EDL-lab2)														
Test	5.2	Average												
Date	4/17/03				Time	0415								
Location					EDL first floor hall & parking lot									
Test Coordinator:					W. Harris									
Test Personnel:					Gary Bastin									
Hardware:					Laptop #BH			Base station:		EDL-lab1				
Address:					00-02-2D-6E-A2-F4			00-50-F2-C7-21-6C						
Encryption (WEP):					128 bit			Firewall:		on	Pings:	Open		
Test Equipment:					Laptop built-in measuring software						Cal:	new		
Antenna:					Rear-12:00 (Vertical)									
Distance:					Variable									
				Laptop							Base station			Comments
Run	Dist	Avg	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise		
		Mbps	11	5.5	2	1		dB	dB		dB	dB		
5.2.1	10	11.0	100.0	0.0	0.0	0.0	43.9	-50.4	-94.1	48.9	-52.6	-101.0		
5.2.2	20	11.0	100.0	0.0	0.0	0.0	44.4	-50.1	-94.6	46.7	-54.9	-101.7		
5.2.3	30	11.0	100.0	0.0	0.0	0.0	47.6	-47.0	-94.4	49.3	-52.0	-101.6		
5.2.4	40	11.0	100.0	0.0	0.0	0.0	42.7	-53.3	-96.0	45.3	-57.0	-101.3		
5.2.5	50	11.0	100.0	0.0	0.0	0.0	40.9	-53.6	-94.4	44.4	-56.9	-101.3		
5.2.6	60	11.0	100.0	0.0	0.0	0.0	30.9	-63.9	-94.1	32.3	-69.6	-102.0		
5.2.7	70	11.0	100.0	0.0	0.0	0.0	29.1	-65.1	-94.0	37.0	-65.7	-102.0		
5.2.8	80	11.0	100.0	0.0	0.0	0.0	30.4	-64.9	-95.6	31.3	-70.1	-102.0		
5.2.9	90	11.0	100.0	0.0	0.0	0.0	28.9	-65.4	-94.4	33.3	-68.6	-102.0		
5.2.10	100	10.8	97.3	1.9	0.0	0.0	29.4	-65.9	-95.4	30.6	-72.0	-102.0		
5.2.11	110	11.0	100.0	0.0	0.0	0.0	25.4	-68.3	-93.6	29.4	-72.9	-102.0		
5.2.12	120	11.0	100.0	0.0	0.0	0.0	28.1	-66.9	-94.7	31.7	-69.7	-102.0		
5.2.13	130	11.0	100.0	0.0	0.0	0.0	27.1	-67.6	-94.3	31.7	-70.7	-102.0		
5.2.14	140	11.0	100.0	0.0	0.0	0.0	26.0	-68.1	-93.7	29.6	-72.7	-102.0		
5.2.15	150	11.0	100.0	0.0	0.0	0.0	26.4	-67.4	-94.0	30.9	-71.0	-102.0		
5.2.16	160	10.4	89.7	8.9	0.3	0.0	22.4	-71.6	-93.6	24.6	-78.1	-102.0		
5.2.17	170	11.0	100.0	0.0	0.0	0.0	24.6	-70.0	-93.7	27.7	-74.6	-102.0		
5.2.18	180	11.0	100.0	0.0	0.0	0.0	25.1	-68.9	-93.9	33.0	-68.3	-102.0		
5.2.19	190	11.0	100.0	0.0	0.0	0.0	26.3	-67.7	-93.4	31.1	-70.9	-102.0		
5.2.20	200	10.6	94.4	4.6	0.0	0.0	21.4	-71.9	-93.1	23.3	-78.4	-102.0		
5.2.21	210	11.0	100.0	0.0	0.0	0.0	22.4	-72.0	-94.6	26.1	-75.7	-102.0		
5.2.22	220	7.9	46.1	51.1	1.1	0.0	17.7	-75.9	-93.9	23.0	-79.1	-102.0		
5.2.23	230	6.6	25.7	66.3	5.4	0.9	18.4	-75.9	-94.1	19.3	-82.7	-102.0		
5.2.24	240	11.0	100.0	0.0	0.0	0.0	21.6	-72.0	-93.6	24.0	-77.7	-102.0		
5.2.25	250	11.0	100.0	0.0	0.0	0.0	24.6	-70.0	-94.3	27.0	-74.7	-102.0		
5.2.26	260	10.9	98.6	0.6	0.0	0.0	23.0	-71.7	-95.1	24.0	-78.3	-102.0		
5.2.27	270	11.0	100.0	0.0	0.0	0.0	21.6	-73.0	-94.0	24.1	-77.7	-102.0		
5.2.28	280	9.1	61.6	41.7	0.0	0.0	18.7	-76.0	-94.4	21.3	-80.4	-102.0		
5.2.29	290	8.3	51.7	47.4	0.0	0.0	18.7	-77.6	-95.6	20.3	-81.9	-102.0		
5.2.30	300	8.5	56.4	42.6	0.0	0.0	16.9	-76.1	-93.4	21.0	-80.4	-102.0		

T-5.2: EDL-lab2 Average SNR With Distance



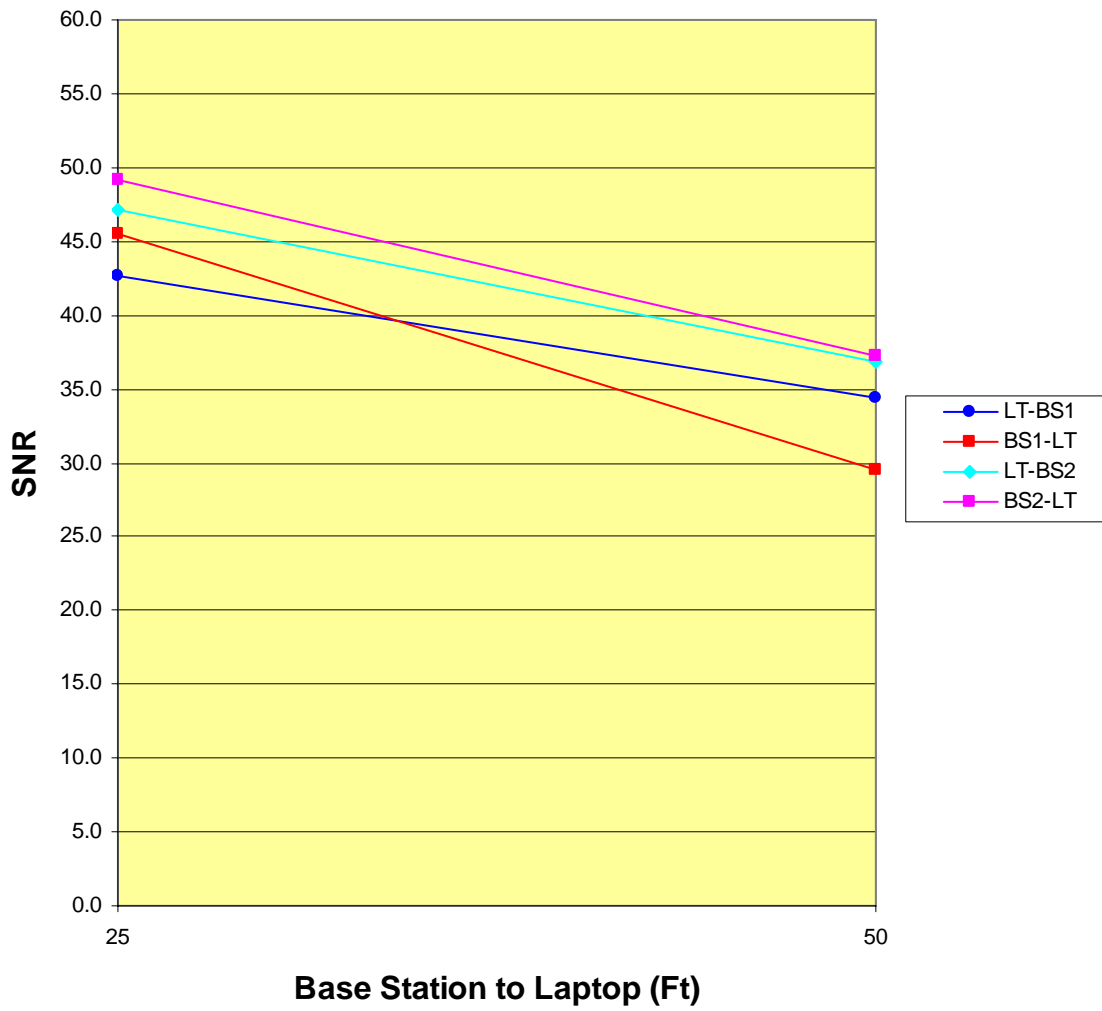


5.3 TEST 5.3: PERFORMANCE WITH TWO BASE STATIONS AT 25 & 50 FT

WiFi Performance With Two Base Stations													
Test	5.3												
Date	4/17/03			Time	0615								
Location			EDL Advanced Network Development Lab & EDL 1st Floor Hall										
Test Coordinator:			W. Harris										
Test Personnel:			none										
Hardware:			Laptop #BH			Base station: EDL-lab1 & EDL-lab2							
Address:			00-02-2D-6E-A2-F4				00-50-F2-C7-21-6C			00-50-F2-C7-C5-6C			
Encryption (WEP):			128 bit			Firewall:		on	Pings:	Open			
Test Equipment:			Laptop built-in measuring software							Cal:	new		
Antenna:			Rear-12:00 (Vertical)										
Distance:			25 & 50 ft										
Barrier:			None										
			Transmission				Laptop			Base station			Comments
Run	Dist	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	
	Ft	Sec	11	5.5	2	1		dB	dB		dB	dB	
5.3.1.1	25	0	100	0	0	0	43	-52	-95	46	-52	-99	EDL-lab1
5.3.1.2	25	30	100	0	0	0	45	-53	-98	45	-54	-99	
5.3.1.3	25	60	100	0	0	0	42	-54	-96	46	-54	-100	
5.3.1.4	25	90	100	0	0	0	41	-53	-94	45	-54	-100	
5.3.1.5	25	120	100	0	0	0	43	-55	-98	45	-54	-100	
5.3.1.6	25	150	100	0	0	0	42	-54	-97	46	-54	-100	
5.3.1.7	25	180	100	0	0	0	43	-54	-97	46	-54	-100	
Avg							42.7	-53.6	-96.4	45.6	-53.7	-99.7	
Median							43.0	-54.0	-97.0	46.0	-54.0	-100.0	
Std Dev							1.3	1.0	1.5	0.5	0.8	0.5	
Mode							43.0	-54.0	-98.0	46.0	-54.0	-100.0	
5.3.2.1	25	0	100	0	0	0	49	-48	-96	49	-52	-102	EDL-lab2
5.3.2.2	25	30	100	0	0	0	47	-49	-96	50	-51	-102	
5.3.2.3	25	60	100	0	0	0	45	-49	-94	49	-53	-102	
5.3.2.4	25	90	100	0	0	0	48	-48	-95	49	-52	-102	
5.3.2.5	25	120	100	0	0	0	49	-49	-97	49	-53	-102	
5.3.2.6	25	150	100	0	0	0	45	-49	-95	49	-52	-102	
5.3.2.7	25	180	100	0	0	0	47	-48	-95	49	-52	-102	
Avg							47.1	-48.6	-95.4	49.1	-52.1	-102.0	
Median							47.0	-49.0	-95.0	49.0	-52.0	-102.0	
Std Dev							1.7	0.5	1.0	0.4	0.7	0.0	
Mode							49.0	-49.0	-95.0	49.0	-52.0	-102.0	
5.3.3.1	50	0	100	0	0	0	37	-58	-95	32	-65	-98	EDL-lab1
5.3.3.2	50	30	100	0	0	0	36	-57	-93	31	-66	-98	
5.3.3.3	50	60	100	0	0	0	36	-57	-92	32	-66	-98	
5.3.3.4	50	90	100	0	0	0	38	-57	-95	31	-67	-98	
5.3.3.5	50	120	100	0	0	0	33	-57	-91	23	-65	-88	
5.3.3.6	50	150	100	0	0	0	31	-58	-88	26	-65	-91	
5.3.3.7	50	180	100	0	0	0	30	-56	-85	32	-65	-97	
Avg							34.4	-57.1	-91.3	29.6	-65.6	-95.4	
Median							36.0	-57.0	-92.0	31.0	-65.0	-98.0	
Std Dev							3.1	0.7	3.7	3.6	0.8	4.2	
Mode							36.0	-57.0	-95.0	32.0	-65.0	-98.0	

Std Dev							3.1	0.7	3.7	3.6	0.8	4.2	
Mode							36.0	-57.0	-95.0	32.0	-65.0	-98.0	
5.3.4.1	50	0	100	0	0	0	37	-58	-95	37	-66	-102	EDL-lab2
5.3.4.2	50	30	100	0	0	0	36	-58	-94	37	-64	-102	
5.3.4.3	50	60	100	0	0	0	38	-58	-96	37	-64	-102	
5.3.4.4	50	90	100	0	0	0	37	-58	-95	37	-65	-102	
5.3.4.5	50	120	100	0	0	0	34	-59	-93	37	-65	-102	
5.3.4.6	50	150	100	0	0	0	38	-58	-96	37	-64	-102	
5.3.4.7	50	180	100	0	0	0	38	-58	-95	39	-64	-102	
Avg							36.9	-58.1	-94.9	37.3	-64.6	-102.0	
Median							37.0	-58.0	-95.0	37.0	-64.0	-102.0	
Std Dev							1.5	0.4	1.1	0.8	0.8	0.0	
Mode							38.0	-58.0	-95.0	37.0	-64.0	-102.0	
Summary													
		Laptop BH			EDL-lab1			Laptop BH			Base station		
Run	X	SNR	Signal	Noise	SNR	Signal	Noise	SNR	Signal	Noise	SNR	Signal	Noise
	Ft		dB	dB		dB	dB		dB	dB		dB	dB
5.3.1	25	42.7	-53.6	-96.4	45.6	-53.7	-99.7	47.1	-48.6	-95.4	49.1	-52.1	-102.0
5.3.2	50	34.4	-57.1	-91.3	29.6	-65.6	-95.4	36.9	-58.1	-94.9	37.3	-64.6	-102.0

T-5.3: WiFi SNR With Two Base Stations



6.0

**TEST 6: WI-FI PERFORMANCE WITH ATTENUATION
BARRIERS**

6.1

TEST 6.1: WI-FI PERFORMANCE WITH ONE PARTITION

WiFi Performance With One Partition													
Test	6.1												
Date	4/11/03			Time	1000								
Location				EDL Advanced Network Development Lab									
Test Coordinator:				W. Harris									
Test Personnel:				none									
Hardware:				Laptop	#BH			Base station:	EDL-lab1				
Address:				00-02-2D-6E-A2-F4					00-50-F2-C7-21-6C				
Encryption (WEP):				128 bit				Firewall:	on	Pings:	Open		
Test Equipment:				Laptop built-in measuring software						Cal:	new		
Antenna:				Rear-12:00 (Vertical)									
Distance:				25 ft									
Barrier:				#1 Single Partition (54 inches high x 58.5 wide x 1.75 thk canvas covered particle board)									
Run	Dist Ft	Time Sec	Transmission Speed (Mbps)				Laptop			Base station			Comments
			11	5.5	2	1	SNR	Signal dB	Noise dB	SNR	Signal dB	Noise dB	
6.1.1.1	NA	0	100	0	0	0	42	-52	-92	45	-54	-100	Baseline
6.1.1.2		30	100	0	0	0	41	-51	-93	46	-54	-100	
6.1.1.3		60	100	0	0	0	42	-51	-94	45	-54	-100	
6.1.1.4		90	100	0	0	0	42	-52	-94	47	-54	-100	
6.1.1.5		120	100	0	0	0	41	-52	-93	45	-54	-100	
6.1.1.6		150	100	0	0	0	41	-50	-91	46	-54	-100	
6.1.1.7		180	100	0	0	0	42	-50	-93	46	-54	-100	
Avg							41.6	-51.1	-92.9	45.7	-54.0	-100.0	
Median							42.0	-51.0	-93.0	46.0	-54.0	-100.0	
Std Dev							0.5	0.9	1.1	0.8	0.0	0.0	
Mode							42.0	-52.0	-93.0	45.0	-54.0	-100.0	
6.1.2.1	2	0	100	0	0	0	36	-56	-91	33	-66	-99	
6.1.2.2	2	30	100	0	0	0	35	-56	-91	34	-65	-100	
6.1.2.3	2	60	100	0	0	0	38	-56	-93	34	-65	-100	
6.1.2.4	2	90	100	0	0	0	36	-59	-94	37	-63	-100	
6.1.2.5	2	120	100	0	0	0	33	-59	-92	39	-60	-100	
6.1.2.6	2	150	100	0	0	0	35	-59	-95	38	-62	-100	
6.1.2.7	2	180	100	0	0	0	38	-58	-96	39	-60	-100	
Avg							35.9	-57.6	-93.1	36.3	-63.0	-99.9	
Median							36.0	-58.0	-93.0	37.0	-63.0	-100.0	
Std Dev							1.8	1.5	2.0	2.6	2.4	0.4	
Mode							36.0	-56.0	-91.0	34.0	-65.0	-100.0	
6.1.3.1	5	0	100	0	0	0	42	-54	-96	39	-60	-100	
6.1.3.2	5	30	100	0	0	0	43	-54	-96	39	-60	-97	
6.1.3.3	5	60	100	0	0	0	38	-55	-94	39	-60	-99	
6.1.3.4	5	90	100	0	0	0	35	-54	-89	30	-59	-88	
6.1.3.5	5	120	100	0	0	0	36	-56	-91	41	-58	-98	
6.1.3.6	5	150	100	0	0	0	38	-55	-94	39	-59	-97	
6.1.3.7	5	180	100	0	0	0	38	-54	-92	41	-58	-100	
Avg							38.6	-54.6	-93.1	38.3	-59.1	-97.0	
Median							38.0	-54.0	-94.0	39.0	-59.0	-98.0	
Std Dev							2.9	0.8	2.6	3.8	0.9	4.2	
Mode							38.0	-54.0	-96.0	39.0	-60.0	-100.0	

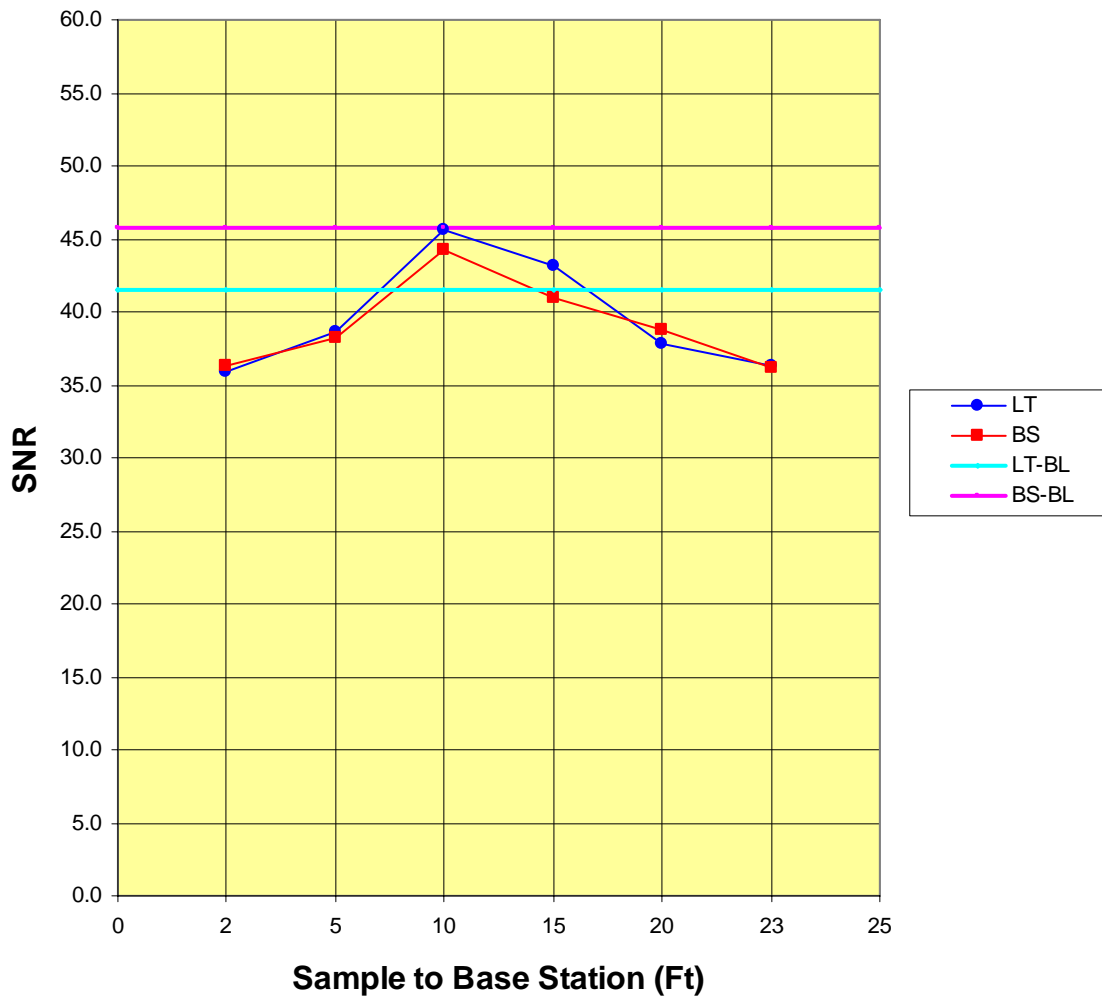
ECT Phase 2 – Vol. 2 – Appendices

6.1.4.1	10	0	100	0	0	0	44	-48	-92	44	-56	-100	
6.1.4.2	10	30	100	0	0	0	50	-47	-97	45	-54	-100	
6.1.4.3	10	60	100	0	0	0	45	-48	-93	44	-55	-100	
6.1.4.4	10	90	100	0	0	0	44	-47	-92	45	-54	-100	
6.1.4.5	10	120	100	0	0	0	46	-47	-94	45	-54	-100	
6.1.4.6	10	150	100	0	0	0	45	-49	-93	43	-56	-100	
6.1.4.7	10	180	100	0	0	0	45	-50	-95	44	-56	-100	
Avg							45.6	-48.0	-93.7	44.3	-55.0	-100.0	
Median							45.0	-48.0	-93.0	44.0	-55.0	-100.0	
Std Dev							2.1	1.2	1.8	0.8	1.0	0.0	
Mode							45.0	-47.0	-92.0	44.0	-56.0	-100.0	
6.1.5.1	15	0	100	0	0	0	42	-50	-91	43	-56	-100	
6.1.5.2	15	30	100	0	0	0	46	-50	-96	41	-58	-100	
6.1.5.3	15	60	100	0	0	0	41	-52	-93	39	-60	-100	
6.1.5.4	15	90	100	0	0	0	41	-52	-92	42	-59	-100	
6.1.5.5	15	120	100	0	0	0	45	-52	-97	40	-59	-100	
6.1.5.6	15	150	100	0	0	0	44	-51	-95	42	-58	-100	
6.1.5.7	15	180	100	0	0	0	43	-52	-93	40	-59	-100	
Avg							43.1	-51.3	-93.9	41.0	-58.4	-100.0	
Median							43.0	-52.0	-93.0	41.0	-59.0	-100.0	
Std Dev							2.0	1.0	2.2	1.4	1.3	0.0	
Mode							41.0	-52.0	-93.0	42.0	-59.0	-100.0	
6.1.6.1	20	0	100	0	0	0	39	-53	-93	38	-62	-99	
6.1.6.2	20	30	100	0	0	0	40	-52	-92	42	-58	-100	
6.1.6.3	20	60	100	0	0	0	34	-55	-90	38	-61	-100	
6.1.6.4	20	90	100	0	0	0	37	-56	-92	39	-60	-100	
6.1.6.5	20	120	100	0	0	0	37	-57	-94	38	-61	-100	
6.1.6.6	20	150	100	0	0	0	39	-56	-95	39	-60	-100	
6.1.6.7	20	180	100	0	0	0	39	-56	-95	37	-62	-100	
Avg							37.9	-55.0	-93.0	38.7	-60.6	-99.9	
Median							39.0	-56.0	-93.0	38.0	-61.0	-100.0	
Std Dev							2.0	1.8	1.8	1.6	1.4	0.4	
Mode							39.0	-56.0	-92.0	38.0	-62.0	-100.0	
6.1.7.1	23	0	100	0	0	0	34	-59	-93	35	-64	-100	
6.1.7.2	23	30	100	0	0	0	36	-57	-95	36	-63	-100	
6.1.7.3	23	60	100	0	0	0	37	-57	-94	36	-63	-100	
6.1.7.4	23	90	100	0	0	0	40	-55	-94	39	-60	-100	
6.1.7.5	23	120	100	0	0	0	36	-56	-92	38	-61	-100	
6.1.7.6	23	150	100	0	0	0	34	-59	-92	35	-64	-100	
6.1.7.7	23	180	100	0	0	0	37	-59	-96	34	-65	-100	
Avg							36.3	-57.4	-93.7	36.1	-62.9	-100.0	
Median							36.0	-57.0	-94.0	36.0	-63.0	-100.0	
Std Dev							2.1	1.6	1.5	1.8	1.8	0.0	
Mode							34.0	-59.0	-94.0	35.0	-64.0	-100.0	

ECT Phase 2 – Vol. 2 – Appendices

Summary													
Run	X	Time	LT	BS			Laptop			Base station			Comments
	Ft	Sec	BL	BL			SNR	Signal	Noise	SNR	Signal	Noise	
								dB	dB		dB	dB	
6.1.1	0		41.6	45.7									
6.1.2	2		41.6	45.7			35.9	-57.6	-93.1	36.3	-63.0	-99.9	
6.1.3	5		41.6	45.7			38.6	-54.6	-93.1	38.3	-59.1	-97.0	
6.1.4	10		41.6	45.7			45.6	-48.0	-93.7	44.3	-55.0	-100.0	
6.1.5	15		41.6	45.7			43.1	-51.3	-93.9	41.0	-58.4	-100.0	
6.1.6	20		41.6	45.7			37.9	-55.0	-93.0	38.7	-60.6	-99.9	
6.1.7	23		41.6	45.7			36.3	-57.4	-93.7	36.1	-62.9	-100.0	
6.1.8	25		41.6	45.7									

T-6.1: WiFi SNR With One Partition



6.2

TEST 6.2: WI-FI PERFORMANCE WITH TWO PARTITIONS

WiFi Performance With Two Partitions													
Test	6.2												
Date				Time									
Location			EDL Advanced Network Development Lab										
Test Coordinator:			W. Harris										
Test Personnel:			none										
Hardware:			Laptop	#BH			Base station:	EDL-lab1					
Address:			00-02-2D-6E-A2-F4				00-50-F2-C7-21-6C						
Encryption (WEP):			128 bit				Firewall:	on	Pings:	Open			
Test Equipment:			Laptop built-in measuring software							Cal:	new		
Antenna:			Rear-12:00 (Vertical)										
Distance:			25 ft										
Barrier:			#2 Two Partitions (1/2 inch high x 4 wide x 1.88 thk canvas covered particle board)										
			Transmission				Laptop			Base station			Comments
Run	Dist	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	
	Ft	Sec	11	5.5	2	1		dB	dB		dB	dB	
6.2.1.1	NA	0	100	0	0	0	45	-49	-95	43	-54	-96	Baseline
6.2.1.2		30	100	0	0	0	46	-47	-94	45	-54	-97	
6.2.1.3		60	100	0	0	0	43	-49	-93	43	-54	-98	
6.2.1.4		90	100	0	0	0	43	-49	-93	46	-54	-100	
6.2.1.5		120	100	0	0	0	45	-49	-95	45	-54	-100	
6.2.1.6		150	100	0	0	0	47	-49	-97	46	-54	-100	
6.2.1.7		180	100	0	0	0	42	-50	-92	45	-55	-100	
Avg							44.4	-48.9	-94.1	44.7	-54.1	-98.7	
Median							45.0	-49.0	-94.0	45.0	-54.0	-100.0	
Std Dev							1.8	0.9	1.7	1.3	0.4	1.7	
Mode							45.0	-49.0	-95.0	45.0	-54.0	-100.0	
6.2.2.1	2	0	100	0	0	0	40	-55	-95	40	-59	-99	
6.2.2.2	2	30	100	0	0	0	35	-57	-91	37	-62	-99	
6.2.2.3	2	60	100	0	0	0	39	-57	-95	38	-61	-98	
6.2.2.4	2	90	100	0	0	0	39	-57	-96	38	-62	-99	
6.2.2.5	2	120	100	0	0	0	37	-58	-95	35	-63	-98	
6.2.2.6	2	150	100	0	0	0	39	-55	-93	40	-59	-99	
6.2.2.7	2	180	100	0	0	0	35	-58	-94	35	-64	-98	
Avg							37.7	-56.7	-94.1	37.6	-61.4	-98.6	
Median							39.0	-57.0	-95.0	38.0	-62.0	-99.0	
Std Dev							2.1	1.3	1.7	2.1	1.9	0.5	
Mode							39.0	-57.0	-95.0	40.0	-59.0	-99.0	

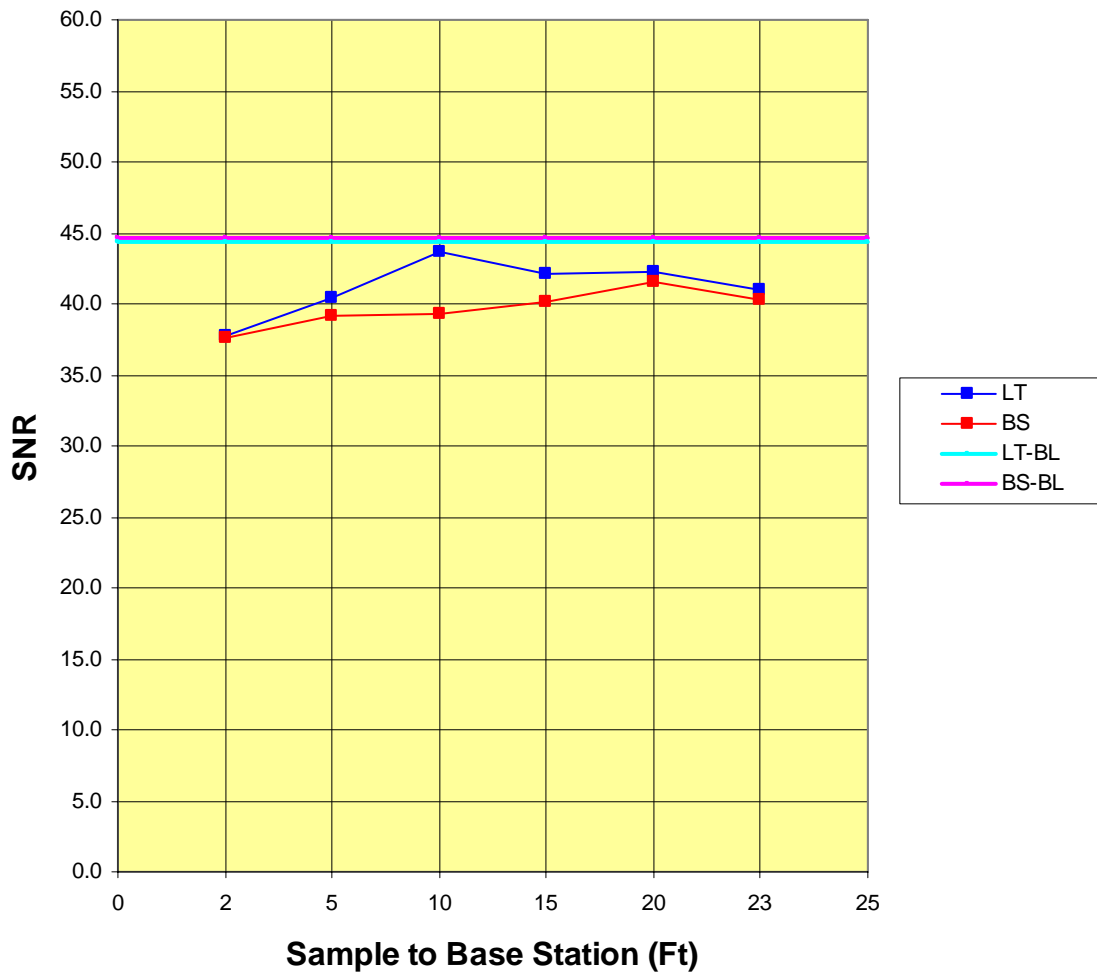
ECT Phase 2 – Vol. 2 – Appendices

6.2.3.1	5	0	100	0	0	0	42	-54	-97	38	-61	-99	
6.2.3.2	5	30	100	0	0	0	41	-54	-95	39	-60	-100	
6.2.3.3	5	60	100	0	0	0	39	-53	-93	41	-58	-100	
6.2.3.4	5	90	100	0	0	0	40	-56	-96	38	-61	-100	
6.2.3.5	5	120	100	0	0	0	44	-53	-98	39	-60	-100	
6.2.3.6	5	150	100	0	0	0	39	-55	-95	39	-60	-100	
6.2.3.7	5	180	100	0	0	0	38	-55	-92	40	-60	-100	
Avg							40.4	-54.3	-95.1	39.1	-60.0	-99.9	
Median							40.0	-54.0	-95.0	39.0	-60.0	-100.0	
Std Dev							2.1	1.1	2.1	1.1	1.0	0.4	
Mode							39.0	-54.0	-95.0	39.0	-60.0	-100.0	
6.2.4.1	10	0	100	0	0	0	43	-50	-93	40	-59	-100	
6.2.4.2	10	30	100	0	0	0	47	-51	-98	40	-59	-100	
6.2.4.3	10	60	100	0	0	0	46	-50	-96	40	-60	-100	
6.2.4.4	10	90	100	0	0	0	40	-51	-91	40	-60	-100	
6.2.4.5	10	120	100	0	0	0	45	-51	-95	39	-60	-100	
6.2.4.6	10	150	100	0	0	0	43	-51	-94	38	-61	-100	
6.2.4.7	10	180	100	0	0	0	42	-51	-92	38	-62	-100	
Avg							43.7	-50.7	-94.1	39.3	-60.1	-100.0	
Median							43.0	-51.0	-94.0	40.0	-60.0	-100.0	
Std Dev							2.4	0.5	2.4	1.0	1.1	0.0	
Mode							43.0	-51.0	#N/A	40.0	-60.0	-100.0	
6.2.5.1	15	0	100	0	0	0	45	-49	-93	42	-56	-97	
6.2.5.2	15	30	100	0	0	0	41	-51	-91	36	-59	-94	
6.2.5.3	15	60	100	0	0	0	42	-51	-94	41	-58	-99	
6.2.5.4	15	90	100	0	0	0	42	-52	-95	40	-60	-100	
6.2.5.5	15	120	100	0	0	0	40	-53	-93	38	-61	-100	
6.2.5.6	15	150	100	0	0	0	42	-51	-94	42	-58	-100	
6.2.5.7	15	180	100	0	0	0	43	-51	-95	42	-58	-100	
Avg							42.1	-51.1	-93.6	40.1	-58.6	-98.6	
Median							42.0	-51.0	-94.0	41.0	-58.0	-100.0	
Std Dev							1.6	1.2	1.4	2.3	1.6	2.3	
Mode							42.0	-51.0	-93.0	42.0	-58.0	-100.0	
6.2.6.1	20	0	100	0	0	0	40	-57	-96	36	-63	-99	
6.2.6.2	20	30	100	0	0	0	43	-52	-93	42	-57	-100	
6.2.6.3	20	60	100	0	0	0	45	-50	-95	43	-56	-100	
6.2.6.4	20	90	100	0	0	0	40	-51	-91	42	-57	-100	
6.2.6.5	20	120	100	0	0	0	44	-51	-95	43	-56	-99	
6.2.6.6	20	150	100	0	0	0	43	-51	-94	43	-56	-100	
6.2.6.7	20	180	100	0	0	0	41	-50	-92	42	-56	-99	
Avg							42.3	-51.7	-93.7	41.6	-57.3	-99.6	
Median							43.0	-51.0	-94.0	42.0	-56.0	-100.0	
Std Dev							2.0	2.4	1.8	2.5	2.6	0.5	
Mode							40.0	-51.0	-95.0	42.0	-56.0	-100.0	

ECT Phase 2 – Vol. 2 – Appendices

6.2.7.1	23	0	100	0	0	0	40	-54	-94	40	-60	-100	
6.2.7.2	23	30	100	0	0	0	39	-53	-92	41	-58	-100	
6.2.7.3	23	60	100	0	0	0	40	-52	-92	39	-60	-100	
6.2.7.4	23	90	100	0	0	0	41	-52	-93	41	-58	-100	
6.2.7.5	23	120	100	0	0	0	44	-52	-94	41	-58	-100	
6.2.7.6	23	150	100	0	0	0	42	-53	-94	41	-58	-100	
6.2.7.7	23	180	100	0	0	0	41	-53	-94	39	-60	-100	
Avg							41.0	-52.7	-93.3	40.3	-58.9	-100.0	
Median							41.0	-53.0	-94.0	41.0	-58.0	-100.0	
Std Dev							1.6	0.8	1.0	1.0	1.1	0.0	
Mode							40.0	-53.0	-94.0	41.0	-58.0	-100.0	
Summary													
Run	X	Time					Laptop			Base station			Comments
			LT	BS			SNR	Signal	Noise	SNR	Signal	Noise	
			BL	BL				dB	dB		dB	dB	
6.2.1	0		44.4	44.7									
6.2.2	2		44.4	44.7			37.7	-56.7	-94.1	37.6	-61.4	-98.6	
6.2.3	5		44.4	44.7			40.4	-54.3	-95.1	39.1	-60.0	-99.9	
6.2.4	10		44.4	44.7			43.7	-50.7	-94.1	39.3	-60.1	-100.0	
6.2.5	15		44.4	44.7			42.1	-51.1	-93.6	40.1	-58.6	-98.6	
6.2.6	20		44.4	44.7			42.3	-51.7	-93.7	41.6	-57.3	-99.6	
6.2.7	23		44.4	44.7			41.0	-52.7	-93.3	40.3	-58.9	-100.0	
6.2.8	25		44.4	44.7									

T-6.2: WiFi SNR With Two Partitions



6.3 TEST 6.3: WI-FI PERFORMANCE WITH .125-INCH AL SHEET

WiFi Performance With .125-inch Al Sheet													
Test	6.3												
Date	4/8/03			Time	1330								
Location			EDL Advanced Network Development Lab										
Test Coordinator:			W. Harris										
Test Personnel:			none										
Hardware:			Laptop	#BH			Base station:		EDL-lab1				
Address:			00-02-2D-6E-A2-F4				00-50-F2-C7-21-6C						
Encryption (WEP):			128 bit				Firewall:		on	Pings:	Open		
Test Equipment:			Laptop built-in measuring software								Cal:	new	
Antenna:			Rear-12:00 (Vertical)										
Distance:			25 ft										
Barrier:			Aluminum Sheet, 40 x 40 x .125 inches										
			Transmission				Laptop			Base station			Comments
Run	X	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	
	Ft	Sec	11	5.5	2	1		dB	dB		dB	dB	
6.3.1.1	NA	0	100	0	0	0	39	-53	-92	45	-54	-100	Baseline
6.3.1.2	NA	30	100	0	0	0	39	-83	-91	47	-52	-101	
6.3.1.3	NA	60	100	0	0	0	44	-53	-95	45	-52	-100	
6.3.1.4	NA	90	100	0	0	0	43	-52	-95	45	-53	-99	
6.3.1.5	NA	120	100	0	0	0	43	-52	-95	46	-53	-100	
6.3.1.6	NA	150	100	0	0	0	40	-53	-92	44	-55	-100	
6.3.1.7	NA	180	100	0	0	0	42	-54	-96	45	-54	-100	
Avg							41.4	-57.1	-93.7	45.3	-53.3	-100.0	
Median							42.0	-53.0	-95.0	45.0	-53.0	-100.0	
Std Dev							2.1	11.4	2.0	1.0	1.1	0.6	
Mode							39.0	-53.0	-95.0	45.0	-54.0	-100.0	
6.3.2.1	2	0	100	0	0	0	41	-55	-98	42	-57	-98	
6.3.2.2	2	30	100	0	0	0	41	-55	-95	43	-56	-100	
6.3.2.3	2	60	100	0	0	0	39	-54	-95	42	-56	-100	
6.3.2.4	2	90	100	0	0	0	41	-54	-93	42	-56	-100	
6.3.2.5	2	120	100	0	0	0	40	-54	-94	42	-56	-100	
6.3.2.6	2	150	100	0	0	0	38	-55	-94	40	-58	-100	
6.3.2.7	2	180	100	0	0	0	39	-56	-93	38	-60	-99	
Avg							39.9	-54.7	-94.6	41.3	-57.0	-99.6	
Median							40.0	-55.0	-94.0	42.0	-56.0	-100.0	
Std Dev							1.2	0.8	1.7	1.7	1.5	0.8	
Mode							41.0	-55.0	-95.0	42.0	-56.0	-100.0	

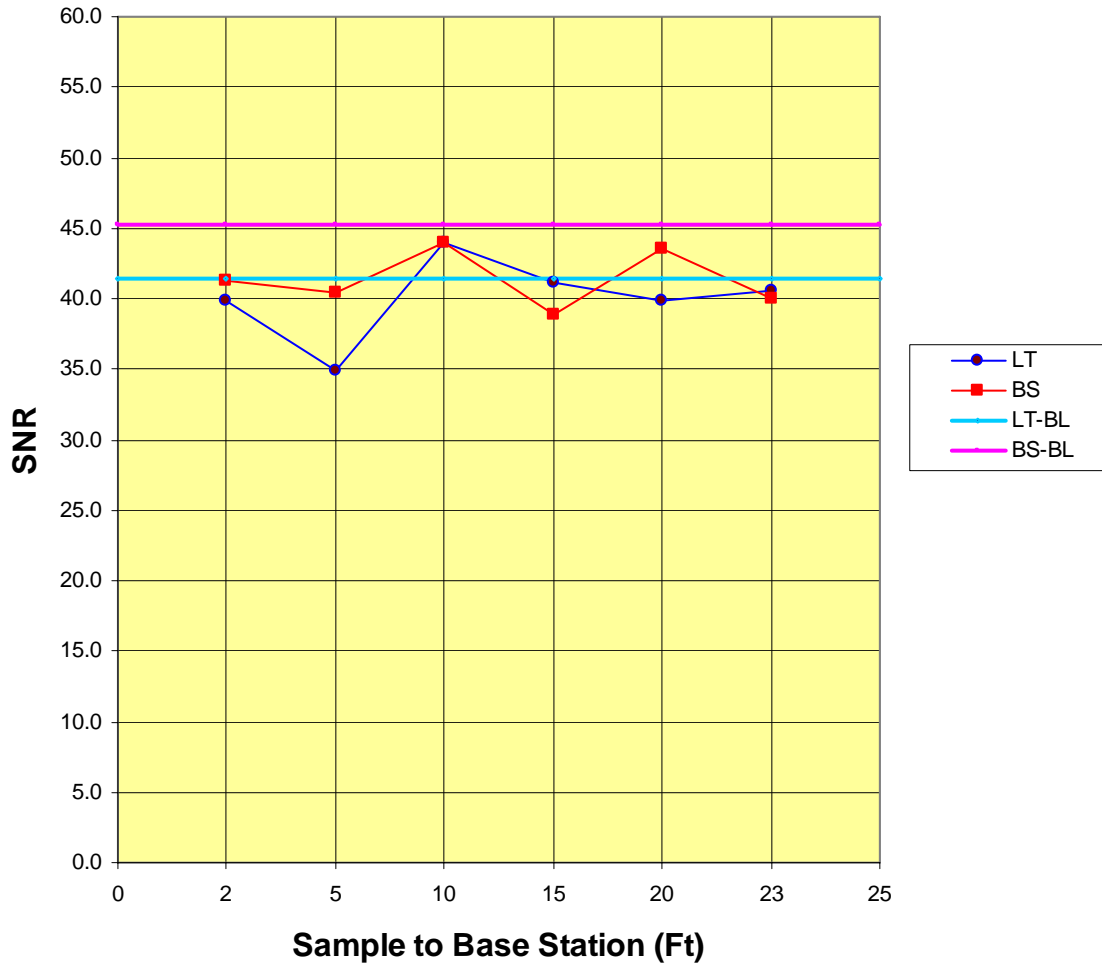
ECT Phase 2 – Vol. 2 – Appendices

6.3.3.1	5	0	100	0	0	0	34	-59	-94	41	-58	-99	
6.3.3.2	5	30	100	0	0	0	33	-59	-92	38	-59	-100	
6.3.3.3	5	60	100	0	0	0	38	-58	-96	41	-58	-100	
6.3.3.4	5	90	100	0	0	0	34	-59	-94	40	-58	-100	
6.3.3.5	5	120	100	0	0	0	38	-59	-97	40	-58	-100	
6.3.3.6	5	150	100	0	0	0	32	-59	-92	41	-57	-100	
6.3.3.7	5	180	100	0	0	0	35	-60	-95	42	-58	-100	
Avg							34.9	-59.0	-94.3	40.4	-58.0	-99.9	
Median							34.0	-59.0	-94.0	41.0	-58.0	-100.0	
Std Dev							2.3	0.6	1.9	1.3	0.6	0.4	
Mode							34.0	-59.0	-94.0	41.0	-58.0	-100.0	
6.3.4.1	10	0	100	0	0	0	42	-50	-92	44	-53	-99	
6.3.4.2	10	30	100	0	0	0	42	-50	-91	45	-54	-99	
6.3.4.3	10	60	100	0	0	0	45	-50	-95	44	-54	-99	
6.3.4.4	10	90	100	0	0	0	43	-50	-94	44	-55	-99	
6.3.4.5	10	120	100	0	0	0	47	-52	-98	43	-56	-99	
6.3.4.6	10	150	100	0	0	0	45	-50	-96	44	-54	-100	
6.3.4.7	10	180	100	0	0	0	44	-51	-94	44	-55	-100	
Avg							44.0	-50.4	-94.3	44.0	-54.4	-99.3	
Median							44.0	-50.0	-94.0	44.0	-54.0	-99.0	
Std Dev							1.8	0.8	2.4	0.6	1.0	0.5	
Mode							42.0	-50.0	-94.0	44.0	-54.0	-99.0	
6.3.5.1	15	0	100	0	0	0	40	-53	-94	40	-58	-100	
6.3.5.2	15	30	100	0	0	0	40	-53	-94	40	-58	-100	
6.3.5.3	15	60	100	0	0	0	40	-55	-96	36	-61	-100	
6.3.5.4	15	90	100	0	0	0	44	-53	-97	40	-58	-100	
6.3.5.5	15	120	100	0	0	0	40	-53	-94	38	-59	-100	
6.3.5.6	15	150	100	0	0	0	43	-54	-97	39	-59	-100	
6.3.5.7	15	180	100	0	0	0	41	-54	-96	39	-60	-100	
Avg							41.1	-53.6	-95.4	38.9	-59.0	-100.0	
Median							40.0	-53.0	-96.0	39.0	-59.0	-100.0	
Std Dev							1.7	0.8	1.4	1.5	1.2	0.0	
Mode							40.0	-53.0	-94.0	40.0	-58.0	-100.0	

ECT Phase 2 – Vol. 2 – Appendices

6.3.6.1	20	0	100	0	0	0	38	-56	-93	43	-56	-99	
6.3.6.2	20	30	100	0	0	0	41	-56	-97	44	-56	-100	
6.3.6.3	20	60	100	0	0	0	41	-56	-96	44	-56	-100	
6.3.6.4	20	90	100	0	0	0	42	-56	-97	44	-56	-100	
6.3.6.5	20	120	100	0	0	0	39	-57	-96	44	-56	-100	
6.3.6.6	20	150	100	0	0	0	39	-56	-95	43	-56	-100	
6.3.6.7	20	180	100	0	0	0	39	-54	93	43	-56	-100	
Avg							39.9	-55.9	-68.7	43.6	-56.0	-99.9	
Median							39.0	-56.0	-96.0	44.0	-56.0	-100.0	
Std Dev							1.5	0.9	71.3	0.5	0.0	0.4	
Mode							39.0	-56.0	-97.0	44.0	-56.0	-100.0	
6.3.7.1	23	0	100	0	0	0	40	-54	-94	39	-59	-98	
6.3.7.2	23	30	100	0	0	0	40	-57	-97	40	-60	-98	
6.3.7.3	23	60	100	0	0	0	41	-54	-95	40	-58	-99	
6.3.7.4	23	90	100	0	0	0	41	-55	-95	39	-60	-97	
6.3.7.5	23	120	100	0	0	0	39	-53	-93	41	-56	-97	
6.3.7.6	23	150	100	0	0	0	39	-54	-93	41	-58	-99	
6.3.7.7	23	180	100	0	0	0	44	-54	-98	40	-58	-99	
Avg							40.6	-54.4	-95.0	40.0	-58.4	-98.1	
Median							40.0	-54.0	-95.0	40.0	-58.0	-98.0	
Std Dev							1.7	1.3	1.9	0.8	1.4	0.9	
Mode							40.0	-54.0	-95.0	40.0	-58.0	-99.0	
Summary													
Run	X	Time					Laptop			Base station			Comments
			LT	BS			SNR	Signal	Noise	SNR	Signal	Noise	
			BL	BL				dB	dB		dB	dB	
6.3.1	0		41.4	45.3									
6.3.2	2		41.4	45.3			39.9	-54.7	-94.6	41.3	-57.0	-99.6	
6.3.3	5		41.4	45.3			34.9	-59.0	-94.3	40.4	-58.0	-99.9	
6.3.4	10		41.4	45.3			44.0	-50.4	-94.3	44.0	-54.4	-99.3	
6.3.5	15		41.4	45.3			41.1	-53.6	-95.4	38.9	-59.0	-100.0	
6.3.6	20		41.4	45.3			39.9	-55.9	-68.7	43.6	-56.0	-99.9	
6.3.7	23		41.4	45.3			40.6	-54.4	-95.0	40.0	-58.4	-98.1	
6.3.1	25		41.4	45.3									

T-6.3: WiFi SNR With .125-inch Al Sheet



6.4 TEST 6.4: WI-FI PERFORMANCE WITH .187-INCH AL SHEET

WiFi Performance With .187-inch Al Sheet													
Test	6.4												
Date													
Location			EDL Advanced Network Development Lab										
Test Coordinator:			W. Harris										
Test Personnel:			none										
Hardware:			Laptop	#BH			Base station:	EDL-lab 1					
Address:			00-02-2D-6E-A2-F4				00-50-F2-C7-21-6C						
Encryption (WEP):			128 bit				Firewall:	on		Pings:	Open		
Test Equipment:			Laptop built-in measuring software								Cal:	new	
Antenna:			Rear-12:00 (Vertical)										
Distance:			25 ft										
Barrier:			Aluminum Sheet, 30.5 x 36 x .187 inches										
Run	X Ft	Time Sec	Transmission Speed (Mbps)				Laptop			Base station			Comments
			11	5.5	2	1	SNR	Signal dB	Noise dB	SNR	Signal dB	Noise dB	
6.4.1.1	NA	0	100	0	0	0	49	-46	-95	47	-52	-99	Baseline
6.4.1.2		30	100	0	0	0	45	-49	-94	46	-53	-99	
6.4.1.3		60	100	0	0	0	45	-47	-93	46	-53	-99	
6.4.1.4		90	100	0	0	0	44	-49	-94	45	-53	-100	
6.4.1.5		120	100	0	0	0	47	-48	-94	45	-53	-100	
6.4.1.6		150	100	0	0	0	48	-47	-94	46	-53	-100	
6.4.1.7		180	100	0	0	0	46	-48	-93	45	-53	-100	
Avg							46.3	-47.7	-93.9	45.7	-52.9	-99.6	
Median							46.0	-48.0	-94.0	46.0	-53.0	-100.0	
Std Dev							1.8	1.1	0.7	0.8	0.4	0.5	
Mode							45.0	-49.0	-94.0	46.0	-53.0	-100.0	
6.4.2.1	2	0	100	0	0	0	41	-53	-98	44	-57	-100	
6.4.2.2	2	30	100	0	0	0	42	-52	-99	42	-56	-100	
6.4.2.3	2	60	100	0	0	0	41	-54	-96	43	-56	-100	
6.4.2.4	2	90	100	0	0	0	39	-53	-93	42	-56	-100	
6.4.2.5	2	120	100	0	0	0	39	-55	-94	44	-56	-98	
6.4.2.6	2	150	100	0	0	0	35	-60	-93	43	-55	-98	
6.4.2.7	2	180	100	0	0	0	40	-54	-94	42	-56	-100	
Avg							39.6	-54.4	-95.3	42.9	-56.0	-99.4	
Median							40.0	-54.0	-94.0	43.0	-56.0	-100.0	
Std Dev							2.3	2.6	2.4	0.9	0.6	1.0	
Mode							41.0	-53.0	-93.0	42.0	-56.0	-100.0	

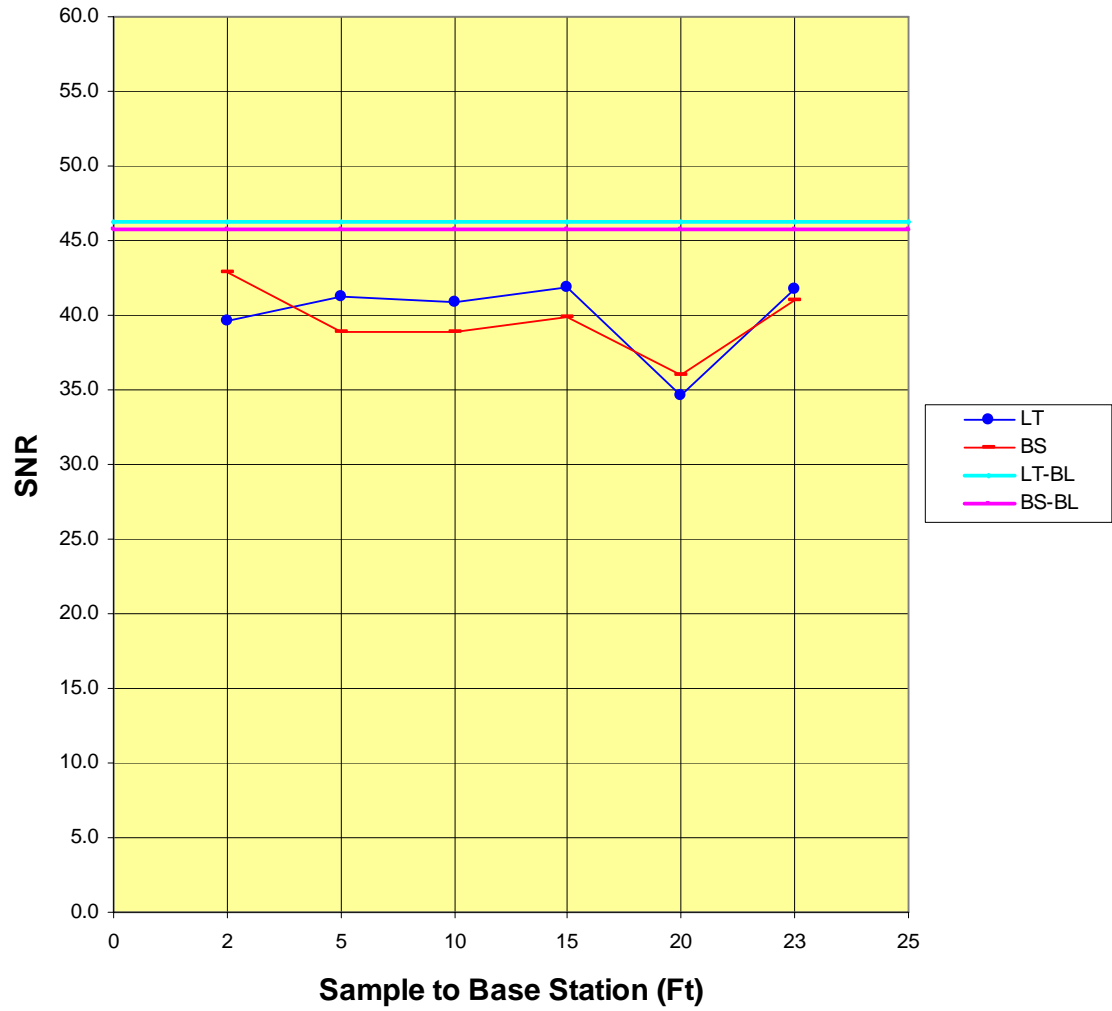
ECT Phase 2 – Vol. 2 – Appendices

6.4.3.1	5	0	100	0	0	0	45	-50	-95	43	-54	-98	
6.4.3.2	5	30	100	0	0	0	41	-50	-97	36	-62	-100	
6.4.3.3	5	60	100	0	0	0	43	-53	-97	39	-60	-100	
6.4.3.4	5	90	100	0	0	0	36	-55	-92	38	-61	-100	
6.4.3.5	5	120	100	0	0	0	39	-55	-93	38	-60	-100	
6.4.3.6	5	150	100	0	0	0	40	-54	-94	39	-60	-100	
6.4.3.7	5	180	100	0	0	0	45	-55	-100	39	-60	-100	
Avg							41.3	-53.1	-95.4	38.9	-59.6	-99.7	
Median							41.0	-54.0	-95.0	39.0	-60.0	-100.0	
Std Dev							3.3	2.3	2.8	2.1	2.6	0.8	
Mode							45.0	-55.0	-97.0	39.0	-60.0	-100.0	
6.4.4.1	10	0	100	0	0	0	41	-54	-97	38	-59	-100	
6.4.4.2	10	30	100	0	0	0	41	-54	-95	39	-60	-100	
6.4.4.3	10	60	100	0	0	0	42	-54	-96	39	-59	-100	
6.4.4.4	10	90	100	0	0	0	40	-54	-93	38	-60	-100	
6.4.4.5	10	120	100	0	0	0	42	-54	-96	39	-60	-100	
6.4.4.6	10	150	100	0	0	0	38	-54	-92	39	-59	-100	
6.4.4.7	10	180	100	0	0	0	42	-54	-97	40	-59	-100	
Avg							40.9	-54.0	-95.1	38.9	-59.4	-100.0	
Median							41.0	-54.0	-96.0	39.0	-59.0	-100.0	
Std Dev							1.5	0.0	2.0	0.7	0.5	0.0	
Mode							42.0	-54.0	-97.0	39.0	-59.0	-100.0	
6.4.5.1	15	0	100	0	0	0	41	-57	-99	39	-60	-99	
6.4.5.2	15	30	100	0	0	0	40	-54	-94	40	-58	-99	
6.4.5.3	15	60	100	0	0	0	43	-54	-96	39	-59	-100	
6.4.5.4	15	90	100	0	0	0	42	-54	-95	39	-59	-100	
6.4.5.5	15	120	100	0	0	0	45	-54	-99	40	-58	-100	
6.4.5.6	15	150	100	0	0	0	38	-55	-94	40	-58	-100	
6.4.5.7	15	180	100	0	0	0	44	-53	-98	42	-57	-100	
Avg							41.9	-54.4	-96.4	39.9	-58.4	-99.7	
Median							42.0	-54.0	-96.0	40.0	-58.0	-100.0	
Std Dev							2.4	1.3	2.2	1.1	1.0	0.5	
Mode							#N/A	-54.0	-99.0	39.0	-58.0	-100.0	

ECT Phase 2 – Vol. 2 – Appendices

6.4.6.1	20	0	100	0	0	0	34	-59	-93	36	-62	-98	
6.4.6.2	20	30	100	0	0	0	31	-59	-97	37	-61	-100	
6.4.6.3	20	60	100	0	0	0	34	-61	-96	36	-62	-100	
6.4.6.4	20	90	100	0	0	0	35	-59	-94	33	-65	-100	
6.4.6.5	20	120	100	0	0	0	37	-58	-94	37	-61	-100	
6.4.6.6	20	150	100	0	0	0	37	-56	-92	39	-58	-100	
6.4.6.7	20	180	100	0	0	0	34	-60	-95	34	-65	-100	
Avg							34.6	-58.9	-94.4	36.0	-62.0	-99.7	
Median							34.0	-59.0	-94.0	36.0	-62.0	-100.0	
Std Dev							2.1	1.6	1.7	2.0	2.4	0.8	
Mode							34.0	-59.0	-94.0	36.0	-62.0	-100.0	
6.4.7.1	23	0	100	0	0	0	41	-54	-96	38	-60	-100	
6.4.7.2	23	30	100	0	0	0	41	-51	-93	41	-57	-100	
6.4.7.3	23	60	100	0	0	0	43	-54	-95	41	-58	-100	
6.4.7.4	23	90	100	0	0	0	41	-51	-91	43	-56	-100	
6.4.7.5	23	120	100	0	0	0	40	-54	-94	39	-60	-100	
6.4.7.6	23	150	100	0	0	0	42	-50	-94	43	-55	-100	
6.4.7.7	23	180	100	0	0	0	44	-52	-95	42	-56	-100	
Avg							41.7	-52.3	-94.0	41.0	-57.4	-100.0	
Median							41.0	-52.0	-94.0	41.0	-57.0	-100.0	
Std Dev							1.4	1.7	1.6	1.9	2.0	0.0	
Mode							41.0	-54.0	-95.0	41.0	-60.0	-100.0	
Summary													
							Laptop			Base station			Comments
Run	X	Time	LT	BS			SNR	Signal	Noise	SNR	Signal	Noise	
	Ft	Sec	BL	BL				dB	dB		dB	dB	
6.4.1	0		46.3	45.7									
6.4.2	2		46.3	45.7			39.6	-54.4	-95.3	42.9	-56.0	-99.4	
6.4.3	5		46.3	45.7			41.3	-53.1	-95.4	38.9	-59.6	-99.7	
6.4.4	10		46.3	45.7			40.9	-54.0	-95.1	38.9	-59.4	-100.0	
6.4.5	15		46.3	45.7			41.9	-54.4	-96.4	39.9	-58.4	-99.7	
6.4.6	20		46.3	45.7			34.6	-58.9	-94.4	36.0	-62.0	-99.7	
6.4.7	23		46.3	45.7			41.7	-52.3	-94.0	41.0	-57.4	-100.0	
6.4.1	25		46.3	45.7									

T-6.4: WiFi SNR With .187-inch Al Sheet



6.5 TEST 6.5: WI-FI PERFORMANCE WITH .062-INCH STEEL SHEET

WiFi Performance With .062-inch Steel Sheet													
Test	6.5												
Date	4/8/03												
Time	1500												
Location													
Test Coordinator:													
Test Personnel:													
Hardware:													
Laptop	#BH												
Base station:	EDL-lab 1												
Address:													
Encryption (WEP):	128 bit												
Firewall:	on												
Pings:	Open												
Test Equipment:	Laptop built-in measuring software												
Cal:	new												
Antenna:	Rear-12:00 (Vertical)												
Distance:	25 ft												
Barrier:	Steel Sheet, 75.5 x 37 x .063 inches												
			Transmission				Laptop			Base station			Comments
Run	X	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	
	Ft	Sec	11	5.5	2	1		dB	dB		dB	dB	
6.5.1.1	NA	0	100	0	0	0	44	-51	-96	40	-58	-99	Baseline
6.5.1.2		30	100	0	0	0	43	-51	-94	42	-57	-100	
6.5.1.3		60	100	0	0	0	42	-51	-94	43	-55	-100	
6.5.1.4		90	100	0	0	0	41	-52	-93	43	-56	-100	
6.5.1.5		120	100	0	0	0	42	-53	-100	43	-54	-99	
6.5.1.6		150	100	0	0	0	44	-52	-95	43	-55	-100	
6.5.1.7		180	100	0	0	0	42	-51	-94	46	-54	-100	
Avg							42.6	-51.6	-95.1	42.9	-55.6	-99.7	
Median							42.0	-51.0	-94.0	43.0	-55.0	-100.0	
Std Dev							1.1	0.8	2.3	1.8	1.5	0.5	
Mode							42.0	-51.0	-94.0	43.0	-55.0	-100.0	
6.5.2.1	2	0	100	0	0	0	43	-51	-95	39	-59	-97	
6.5.2.2	2	30	100	0	0	0	41	-54	-95	34	-63	-97	
6.5.2.3	2	60	100	0	0	0	41	-54	-96	37	-62	-98	
6.5.2.4	2	90	100	0	0	0	48	-50	-98	35	-63	-97	
6.5.2.5	2	120	100	0	0	0	43	-51	-95	29	-62	-91	
6.5.2.6	2	150	100	0	0	0	43	-50	-93	39	-58	-97	
6.5.2.7	2	180	100	0	0	0	41	-50	-92	35	-62	-97	
Avg							42.9	-51.4	-94.9	35.4	-61.3	-96.3	
Median							43.0	-51.0	-95.0	35.0	-62.0	-97.0	
Std Dev							2.5	1.8	2.0	3.5	2.0	2.4	
Mode							43.0	-50.0	-95.0	39.0	-62.0	-97.0	

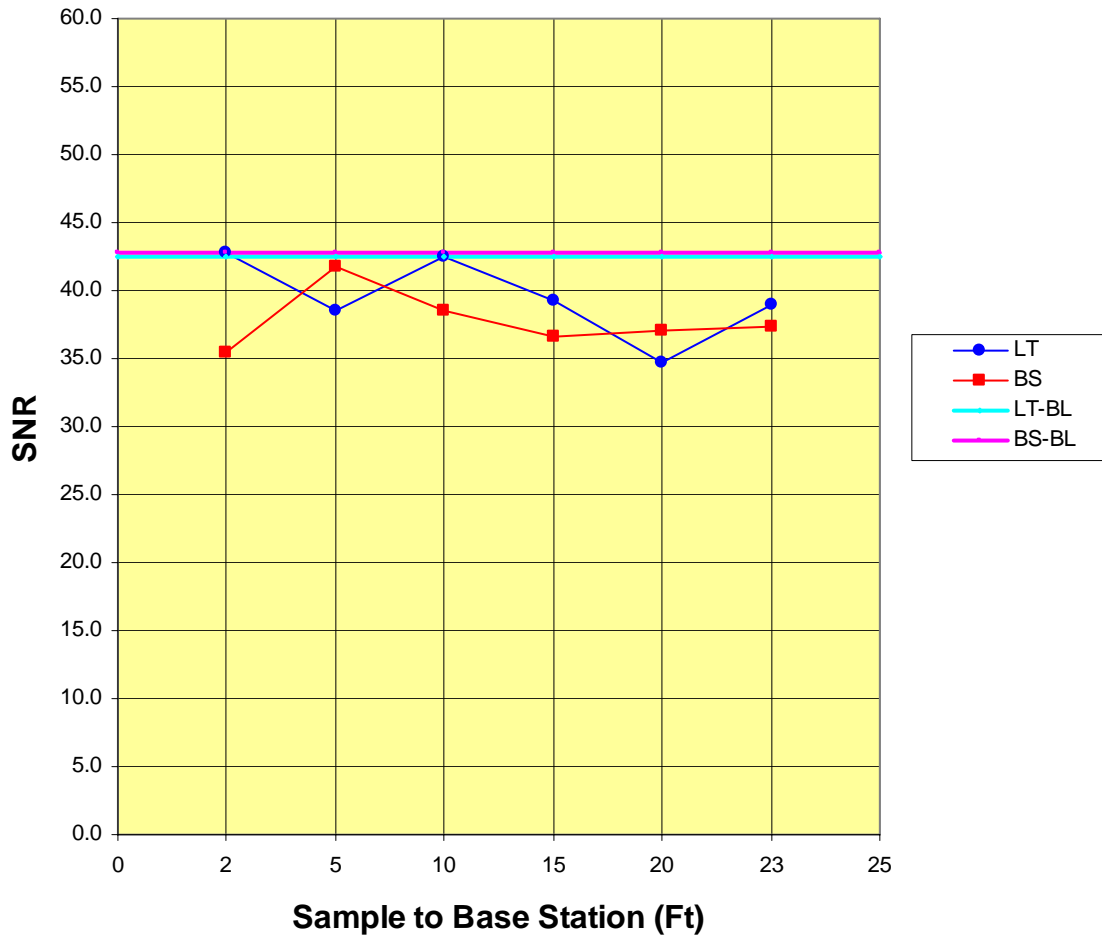
ECT Phase 2 – Vol. 2 – Appendices

6.5.3.1	5	0	100	0	0	0	38	-58	-95	42	-56	-100	
6.5.3.2	5	30	100	0	0	0	40	-56	-96	41	-58	-98	
6.5.3.3	5	60	100	0	0	0	42	-56	-96	41	-56	-97	
6.5.3.4	5	90	100	0	0	0	37	-56	-95	41	-57	-98	
6.5.3.5	5	120	100	0	0	0	37	-57	-94	43	-56	-97	
6.5.3.6	5	150	100	0	0	0	37	-58	-95	43	-56	-98	
6.5.3.7	5	180	100	0	0	0	39	-55	-94	41	-56	-99	
Avg							38.6	-56.6	-95.0	41.7	-56.4	-98.1	
Median							38.0	-56.0	-95.0	41.0	-56.0	-98.0	
Std Dev							1.9	1.1	0.8	1.0	0.8	1.1	
Mode							37.0	-56.0	-95.0	41.0	-56.0	-98.0	
6.5.4.1	10	0	100	0	0	0	41	-54	-95	39	-59	-99	
6.5.4.2	10	30	100	0	0	0	45	-54	-99	39	-60	-100	
6.5.4.3	10	60	100	0	0	0	41	-54	-95	38	-60	-100	
6.5.4.4	10	90	100	0	0	0	42	-54	-96	38	-61	-100	
6.5.4.5	10	120	100	0	0	0	43	-54	-98	36	-62	-99	
6.5.4.6	10	150	100	0	0	0	45	-54	-99	40	-58	-99	
6.5.4.7	10	180	100	0	0	0	41	-52	-93	40	-57	-99	
Avg							42.6	-53.7	-96.4	38.6	-59.6	-99.4	
Median							42.0	-54.0	-96.0	39.0	-60.0	-99.0	
Std Dev							1.8	0.8	2.3	1.4	1.7	0.5	
Mode							41.0	-54.0	-95.0	39.0	-60.0	-99.0	
6.5.5.1	15	0	100	0	0	0	40	-56	-95	37	-61	-100	
6.5.5.2	15	30	100	0	0	0	34	-59	-93	34	-64	-100	
6.5.5.3	15	60	100	0	0	0	37	-58	-96	35	-64	-100	
6.5.5.4	15	90	100	0	0	0	36	-60	-96	34	-64	-100	
6.5.5.5	15	120	100	0	0	0	40	-56	-96	38	-61	-100	
6.5.5.6	15	150	100	0	0	0	43	-54	-95	39	-60	-100	
6.5.5.7	15	180	100	0	0	0	45	-54	-97	39	-58	-100	
Avg							39.3	-56.7	-95.4	36.6	-61.7	-100.0	
Median							40.0	-56.0	-96.0	37.0	-61.0	-100.0	
Std Dev							3.9	2.4	1.3	2.2	2.4	0.0	
Mode							40.0	-56.0	-96.0	34.0	-64.0	-100.0	

ECT Phase 2 – Vol. 2 – Appendices

6.5.6.1	20	0	100	0	0	0	38	-58	-96	37	-62	-98	
6.5.6.2	20	30	100	0	0	0	36	-59	-95	37	-60	-100	
6.5.6.3	20	60	100	0	0	0	31	-61	-92	38	-60	-100	
6.5.6.4	20	90	100	0	0	0	34	-61	-95	36	-62	-100	
6.5.6.5	20	120	100	0	0	0	32	-60	-93	36	-62	-100	
6.5.6.6	20	150	100	0	0	0	36	-62	-97	37	-61	-100	
6.5.6.7	20	180	100	0	0	0	36	-61	-96	38	-59	-100	
Avg							34.7	-60.3	-94.9	37.0	-60.9	-99.7	
Median							36.0	-61.0	-95.0	37.0	-61.0	-100.0	
Std Dev							2.5	1.4	1.8	0.8	1.2	0.8	
Mode							36.0	-61.0	-96.0	37.0	-62.0	-100.0	
6.5.7.1	23	0	100	0	0	0	41	-57	-98	37	-61	-98	
6.5.7.2	23	30	100	0	0	0	37	-57	-93	38	-59	-99	
6.5.7.3	23	60	100	0	0	0	40	-58	-98	35	-63	-100	
6.5.7.4	23	90	100	0	0	0	41	-56	96	38	-60	-100	
6.5.7.5	23	120	100	0	0	0	38	-57	-95	37	-61	-100	
6.5.7.6	23	150	100	0	0	0	38	-56	-94	37	-60	-100	
6.5.7.7	23	180	100	0	0	0	38	-55	-92	39	-58	-100	
Avg							39.0	-56.6	-67.7	37.3	-60.3	-99.6	
Median							38.0	-57.0	-94.0	37.0	-60.0	-100.0	
Std Dev							1.6	1.0	72.2	1.3	1.6	0.8	
Mode							38.0	-57.0	-98.0	37.0	-61.0	-100.0	
Summary													
							Laptop			Base station			Comments
Run	X	Time	LT	BS			SNR	Signal	Noise	SNR	Signal	Noise	
	Ft	Sec	BL	BL				dB	dB		dB	dB	
6.5.1	0		42.6	42.9									
6.5.2	2		42.6	42.9			42.9	-51.4	-94.9	35.4	-61.3	-96.3	
6.5.3	5		42.6	42.9			38.6	-56.6	-95.0	41.7	-56.4	-98.1	
6.5.4	10		42.6	42.9			42.6	-53.7	-96.4	38.6	-59.6	-99.4	
6.5.5	15		42.6	42.9			39.3	-56.7	-95.4	36.6	-61.7	-100.0	
6.5.6	20		42.6	42.9			34.7	-60.3	-94.9	37.0	-60.9	-99.7	
6.5.7	23		42.6	42.9			39.0	-56.6	-67.7	37.3	-60.3	-99.6	
6.5.8	25		42.6	42.9									

T-6.5: WiFi SNR With .063-inch Steel Panel



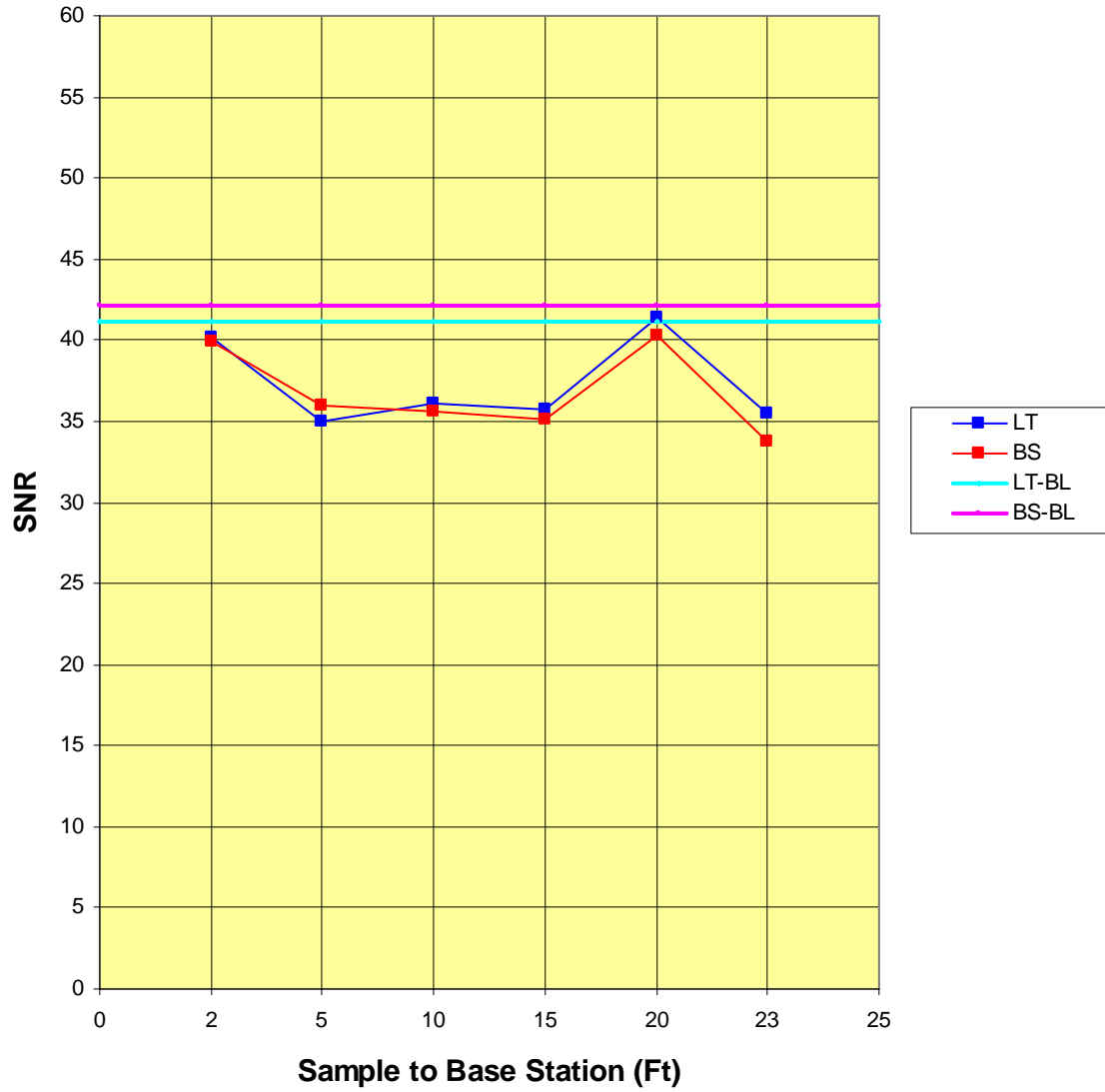
6.6 TEST 6.6: WI-FI PERFORMANCE WITH CINDER BLOCKS (3 H, 1 W, 1 T)

WiFi Performance With Cinder Blocks (3 h, 1 w, 1 t)													
Test	6.6												
Date	4/17/03												
Time	730												
Location	EDL Advanced Network Development Lab												
Test Coordinator:	W. Harris												
Test Personnel:	None												
Hardware:													
Laptop	#BH												
Base station:	EDL-lab1												
Address:													
	00-02-2D-6E-A2-F4												
Encryption (WEP):													
	128 bit												
Firewall:													
	on												
Pings:	Open												
Test Equipment:													
	Laptop built-in measuring software												
Cal:	new												
Antenna:													
	Rear-12:00 (Vertical)												
Distance:													
	25 ft												
Barrier:													
	Cinder Blocks: 3 h, 1 w, 1 t												
Run	X	Time	Transmission				Laptop			Base station			Comments
			Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	
	Ft	Sec	11	5.5	2	1		dB	dB		dB	dB	
6.6.1.1	NA	0	100	0	0	0	41	-53	-93	41	-57	-98	Baseline
6.6.1.2	NA	30	100	0	0	0	46	-50	-95	44	-55	-100	
6.6.1.3	NA	60	100	0	0	0	40	-51	-92	43	-56	-100	
6.6.1.4	NA	90	100	0	0	0	43	-52	-95	42	-57	-100	
6.6.1.5	NA	120	100	0	0	0	38	-54	-92	41	-58	-100	
6.6.1.6	NA	150	100	0	0	0	40	-53	-92	42	-58	-100	
6.6.1.7	NA	180	100	0	0	0	40	-54	-93	42	-57	-100	
Avg							41.1	-52.4	-93.1	42.1	-56.9	-99.7	
Median							40.0	-53.0	-93.0	42.0	-57.0	-100.0	
Std Dev							2.6	1.5	1.3	1.1	1.1	0.8	
Mode							40.0	-53.0	-92.0	42.0	-57.0	-100.0	
6.6.2.1	2	0	100	0	0	0	39	-53	-94	39	-60	-98	
6.6.2.2	2	30	100	0	0	0	38	-53	-92	39	-59	-100	
6.6.2.3	2	60	100	0	0	0	39	-53	-92	40	-59	-100	
6.6.2.4	2	90	100	0	0	0	39	-53	-92	40	-58	-100	
6.6.2.5	2	120	100	0	0	0	42	-52	-93	41	-58	-100	
6.6.2.6	2	150	100	0	0	0	43	-52	-95	41	-58	-100	
6.6.2.7	2	180	100	0	0	0	41	-53	-94	39	-58	-100	
Avg							40.1	-52.7	-93.1	39.9	-58.6	-99.7	
Median							39.0	-53.0	-93.0	40.0	-58.0	-100.0	
Std Dev							1.9	0.5	1.2	0.9	0.8	0.8	
Mode							39.0	-53.0	-92.0	39.0	-58.0	-100.0	
6.6.3.1	5	0	100	0	0	0	32	-61	-93	33	-66	-99	
6.6.3.2	5	30	100	0	0	0	37	-58	-96	35	-65	-101	
6.6.3.3	5	60	100	0	0	0	34	-58	-92	36	-63	-100	
6.6.3.4	5	90	100	0	0	0	37	-57	-94	37	-62	-100	
6.6.3.5	5	120	100	0	0	0	35	-58	-95	38	-61	-100	
6.6.3.6	5	150	100	0	0	0	35	-59	-96	37	-62	-100	
6.6.3.7	5	180	100	0	0	0	35	-59	-94	36	-63	-100	
Avg							35.0	-58.6	-94.3	36.0	-63.1	-100.0	
Median							35.0	-58.0	-94.0	36.0	-63.0	-100.0	
Std Dev							1.7	1.3	1.5	1.6	1.8	0.6	
Mode							35.0	-58.0	-96.0	36.0	-63.0	-100.0	

ECT Phase 2 – Vol. 2 – Appendices

6.6.4.1	10	0	100	0	0	0	37	-58	-95	35	-63	-100	
6.6.4.2	10	30	100	0	0	0	37	-58	-95	36	-63	-100	
6.6.4.3	10	60	100	0	0	0	36	-57	-92	35	-63	-100	
6.6.4.4	10	90	100	0	0	0	34	-58	-92	36	-63	-100	
6.6.4.5	10	120	100	0	0	0	35	-57	-92	36	-63	-100	
6.6.4.6	10	150	100	0	0	0	35	-57	-91	35	-63	-100	
6.6.4.7	10	180	100	0	0	0	39	-58	-96	36	-63	-100	
Avg							36.1	-57.6	-93.3	35.6	-63.0	-100.0	
Median							36.0	-58.0	-92.0	36.0	-63.0	-100.0	
Std Dev							1.7	0.5	2.0	0.5	0.0	0.0	
Mode							37.0	-58.0	-92.0	36.0	-63.0	-100.0	
6.6.5.1	15	0	100	0	0	0	38	-58	-97	36	-63	-99	
6.6.5.2	15	30	100	0	0	0	36	-59	-94	35	-64	-97	
6.6.5.3	15	60	100	0	0	0	35	-59	-94	34	-64	-97	
6.6.5.4	15	90	100	0	0	0	34	-58	-93	35	-64	-98	
6.6.5.5	15	120	100	0	0	0	36	-59	-94	36	-63	-99	
6.6.5.6	15	150	100	0	0	0	35	-59	-94	35	-64	-100	
6.6.5.7	15	180	100	0	0	0	36	-58	-94	35	-64	-100	
Avg							35.7	-58.6	-94.3	35.1	-63.7	-98.6	
Median							36.0	-59.0	-94.0	35.0	-64.0	-99.0	
Std Dev							1.3	0.5	1.3	0.7	0.5	1.3	
Mode							36.0	-59.0	-94.0	35.0	-64.0	-99.0	
6.6.6.1	20	0	100	0	0	0	42	-52	-94	43	-56	-99	
6.6.6.2	20	30	100	0	0	0	44	-52	-96	41	-58	-100	
6.6.6.3	20	60	100	0	0	0	41	-54	-94	41	-58	-100	
6.6.6.4	20	90	100	0	0	0	40	-54	-94	39	-58	-97	
6.6.6.5	20	120	100	0	0	0	41	-54	-94	39	-59	-98	
6.6.6.6	20	150	100	0	0	0	40	-54	-94	39	-59	-97	
6.6.6.7	20	180	100	0	0	0	42	-54	-95	40	-58	-98	
Avg							41.4	-53.4	-94.4	40.3	-58.0	-98.4	
Median							41.0	-54.0	-94.0	40.0	-58.0	-98.0	
Std Dev							1.4	1.0	0.8	1.5	1.0	1.3	
Mode							42.0	-54.0	-94.0	39.0	-58.0	-100.0	
6.6.7.1	23	0	100	0	0	0	31	-62	-94	32	-66	-99	
6.6.7.2	23	30	100	0	0	0	34	-58	-92	34	-65	-100	
6.6.7.3	23	60	100	0	0	0	41	-59	-99	34	-65	-100	
6.6.7.4	23	90	100	0	0	0	34	-59	-93	34	-65	-100	
6.6.7.5	23	120	100	0	0	0	34	-59	-92	34	-65	-100	
6.6.7.6	23	150	100	0	0	0	37	-58	-95	34	-66	-100	
6.6.7.7	23	180	100	0	0	0	37	-59	-95	34	-65	-100	
Avg							35.4	-59.1	-94.3	33.7	-65.3	-99.9	
Median							34.0	-59.0	-94.0	34.0	-65.0	-100.0	
Std Dev							3.2	1.3	2.4	0.8	0.5	0.4	
Mode							34.0	-59.0	-92.0	34.0	-65.0	-100.0	

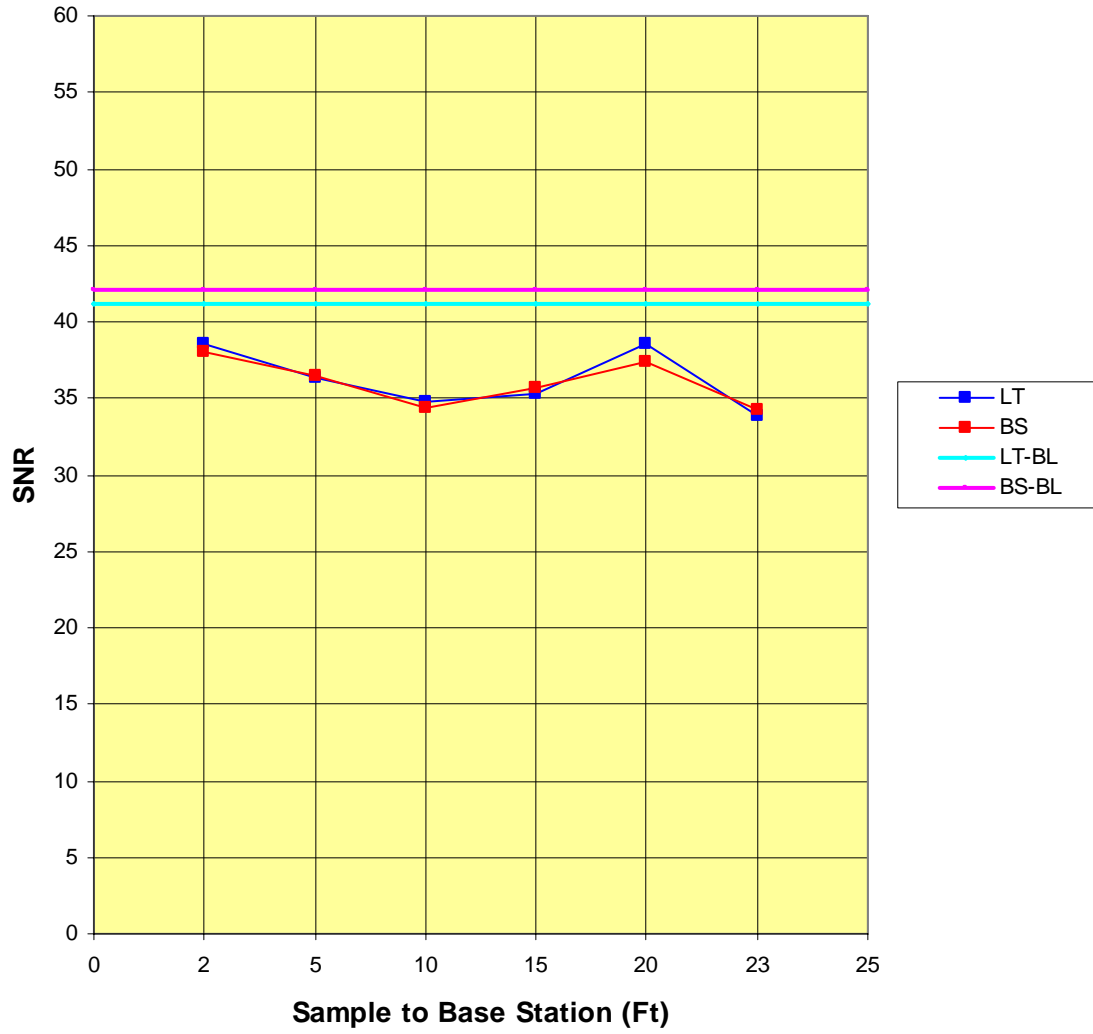
Summary													
Run	X	Time	LT	BS			Laptop			Base station			Comments
	Ft	Sec	BL	BL			SNR	Signal	Noise	SNR	Signal	Noise	
								dB	dB		dB	dB	
6.6.1	0		41.1	42.1									
6.6.2	2		41.1	42.1			40.1	-52.7	-93.1	39.9	-58.6	-99.7	
6.6.3	5		41.1	42.1			35.0	-58.6	-94.3	36.0	-63.1	-100.0	
6.6.4	10		41.1	42.1			36.1	-57.6	-93.3	35.6	-63.0	-100.0	
6.6.5	15		41.1	42.1			35.7	-58.6	-94.3	35.1	-63.7	-98.6	
6.6.6	20		41.1	42.1			41.4	-53.4	-94.4	40.3	-58.0	-98.4	
6.6.7	23		41.1	42.1			35.4	-59.1	-94.3	33.7	-65.3	-99.9	
6.6.8	25		41.1	42.1									

T-6.6: WiFi SNR With CB (3 h, 1w, 1t)

ECT Phase 2 – Vol. 2 – Appendices

6.7.4.1	10	0	100	0	0	0	33	-60	-92	34	-65	-99	
6.7.4.2	10	30	100	0	0	0	36	-59	-94	35	-64	-99	
6.7.4.3	10	60	100	0	0	0	34	-59	-92	35	-64	-100	
6.7.4.4	10	90	100	0	0	0	37	-59	-97	34	-65	-100	
6.7.4.5	10	120	100	0	0	0	35	-58	-92	36	-64	-100	
6.7.4.6	10	150	100	0	0	0	32	-59	-91	32	-64	-99	
6.7.4.7	10	180	100	0	0	0	36	-59	-95	35	-64	-98	
Avg							34.7	-59.0	-93.3	34.4	-64.3	-99.3	
Median							35.0	-59.0	-92.0	35.0	-64.0	-99.0	
Std Dev							1.8	0.6	2.1	1.3	0.5	0.8	
Mode							36.0	-59.0	-92.0	35.0	-64.0	-99.0	
6.7.5.1	15	0	100	0	0	0	36	-58	-95	35	-63	-99	
6.7.5.2	15	30	100	0	0	0	37	-58	-95	36	-64	-100	
6.7.5.3	15	60	100	0	0	0	33	-59	-93	35	-94	-100	
6.7.5.4	15	90	100	0	0	0	34	-59	-92	36	-63	-100	
6.7.5.5	15	120	100	0	0	0	37	-57	-94	36	-63	-100	
6.7.5.6	15	150	100	0	0	0	36	-57	-93	37	-62	-99	
6.7.5.7	15	180	100	0	0	0	34	-59	-92	35	-63	-98	
Avg							35.3	-58.1	-93.4	35.7	-67.4	-99.4	
Median							36.0	-58.0	-93.0	36.0	-63.0	-100.0	
Std Dev							1.6	0.9	1.3	0.8	11.7	0.8	
Mode							36.0	-59.0	-95.0	35.0	-63.0	-100.0	
6.7.6.1	20	0	100	0	0	0	38	-55	-94	38	-61	-99	
6.7.6.2	20	30	100	0	0	0	43	-54	-97	39	-60	-100	
6.7.6.3	20	60	100	0	0	0	36	-56	-92	36	-62	-100	
6.7.6.4	20	90	100	0	0	0	38	-56	-93	37	-62	-100	
6.7.6.5	20	120	100	0	0	0	37	-56	-93	37	-62	-100	
6.7.6.6	20	150	100	0	0	0	39	-56	-95	37	-62	-100	
6.7.6.7	20	180	100	0	0	0	39	-56	-94	38	-61	-100	
Avg							38.6	-55.6	-94.0	37.4	-61.4	-99.9	
Median							38.0	-56.0	-94.0	37.0	-62.0	-100.0	
Std Dev							2.2	0.8	1.6	1.0	0.8	0.4	
Mode							38.0	-56.0	-94.0	37.0	-62.0	-100.0	
6.7.7.1	23	0	100	0	0	0	34	-59	-94	35	-64	-100	
6.7.7.2	23	30	100	0	0	0	34	-60	-94	35	-64	-100	
6.7.7.3	23	60	100	0	0	0	33	-59	-92	35	-64	-100	
6.7.7.4	23	90	100	0	0	0	35	-58	-94	35	-64	-97	
6.7.7.5	23	120	100	0	0	0	32	-61	-93	32	-65	-97	
6.7.7.6	23	150	100	0	0	0	35	-59	-95	33	-64	-98	
6.7.7.7	23	180	100	0	0	0	34	-58	-92	35	-64	-99	
Avg							33.9	-59.1	-93.4	34.3	-64.1	-98.7	
Median							34.0	-59.0	-94.0	35.0	-64.0	-99.0	
Std Dev							1.1	1.1	1.1	1.3	0.4	1.4	
Mode							34.0	-59.0	-94.0	35.0	-64.0	-100.0	

Summary													
Run	X	Time	LT	BS			Laptop			Base station			Comments
	Ft	Sec	BL	BL			SNR	Signal	Noise	SNR	Signal	Noise	
								dB	dB		dB	dB	
6.7.1	0		41.1	42.1									
6.7.2	2		41.1	42.1			38.6	-54.3	-93.0	38.0	-59.9	-97.9	
6.7.3	5		41.1	42.1			36.3	-57.1	-93.6	36.4	-62.6	-99.9	
6.7.4	10		41.1	42.1			34.7	-59.0	-93.3	34.4	-64.3	-99.3	
6.7.5	15		41.1	42.1			35.3	-58.1	-93.4	35.7	-67.4	-99.4	
6.7.6	20		41.1	42.1			38.6	-55.6	-94.0	37.4	-61.4	-99.9	
6.7.7	23		41.1	42.1			33.9	-59.1	-93.4	34.3	-64.1	-98.7	
6.7.8	25		41.1	42.1									

T-6.7: WiFi SNR With CB (3h, 1 w, 2 t)

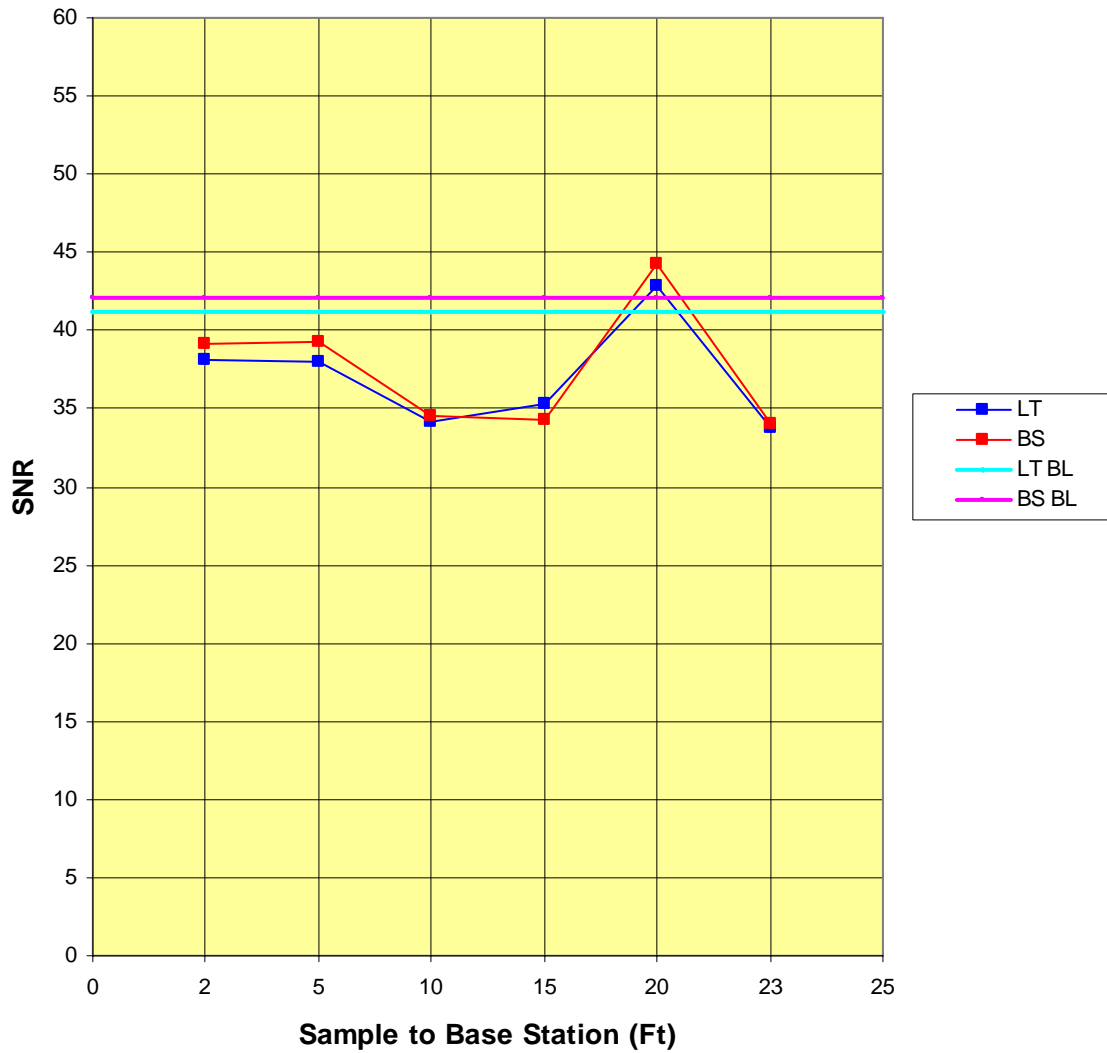
6.8 TEST 6.8: WI-FI PERFORMANCE WITH CINDER BLOCKS (3 H, 2 W, 1 T)

WiFi Performance With Cinder Blocks (3 h, 2 w, 1 t)														
Test	6.8													
Date	4/17/03			Time	730									
Location			EDL Advanced Network Development Lab											
Test Coordinator:			W. Harris											
Test Personnel:			None											
Hardware:			Laptop #BH			Base station:			EDL-lab 1					
Address:			00-02-2D-6E-A2-F4			00-50-F2-C7-21-6C								
Encryption (WEP):			128 bit			Firewall:			on	Pings:	Open			
Test Equipment:			Laptop built-in measuring software								Cal:	new		
Antenna:			Rear-12:00 (Vertical)											
Distance:			25 ft											
Barrier:			Cinder Blocks: 3 h, 2 w, 1 t											
Run	X Ft	Time Sec	Transmission Speed (Mbps)				Laptop			Base station			Comments	
			11	5.5	2	1	SNR	Signal dB	Noise dB	SNR	Signal dB	Noise dB		
6.8.1.1	NA	0	100	0	0	0	41	-53	-93	41	-57	-98	Baseline	
6.8.1.2	NA	30	100	0	0	0	46	-50	-95	44	-55	-100		
6.8.1.3	NA	60	100	0	0	0	40	-51	-92	43	-56	-100		
6.8.1.4	NA	90	100	0	0	0	43	-52	-95	42	-57	-100		
6.8.1.5	NA	120	100	0	0	0	38	-54	-92	41	-58	-100		
6.8.1.6	NA	150	100	0	0	0	40	-53	-92	42	-58	-100		
6.8.1.7	NA	180	100	0	0	0	40	-54	-93	42	-57	-100		
Avg							41.1	-52.4	-93.1	42.1	-56.9	-99.7		
Median							40.0	-53.0	-93.0	42.0	-57.0	-100.0		
Std Dev							2.6	1.5	1.3	1.1	1.1	0.8		
Mode							40.0	-53.0	-92.0	42.0	-57.0	-100.0		
6.8.2.1	2	0	100	0	0	0	39	-55	-96	38	-61	-98		
6.8.2.2	2	30	100	0	0	0	39	-54	-92	40	-59	-100		
6.8.2.3	2	60	100	0	0	0	40	-55	-94	40	-59	-100		
6.8.2.4	2	90	100	0	0	0	37	-55	-92	39	-59	-99		
6.8.2.5	2	120	100	0	0	0	37	-55	-92	39	-60	-100		
6.8.2.6	2	150	100	0	0	0	37	-57	-93	38	-61	-100		
6.8.2.7	2	180	100	0	0	0	38	-56	-95	40	-60	-98		
Avg							38.1	-55.3	-93.4	39.1	-59.9	-99.3		
Median							38.0	-55.0	-93.0	39.0	-60.0	-100.0		
Std Dev							1.2	1.0	1.6	0.9	0.9	1.0		
Mode							37.0	-55.0	-92.0	40.0	-59.0	-100.0		
6.8.3.1	5	0	100	0	0	0	36	-56	-93	37	-62	-99		
6.8.3.2	5	30	100	0	0	0	35	-57	-92	38	-61	-99		
6.8.3.3	5	60	100	0	0	0	38	-54	-92	42	-58	-100		
6.8.3.4	5	90	100	0	0	0	39	-55	-93	39	-59	-98		
6.8.3.5	5	120	100	0	0	0	39	-54	-94	39	-60	-99		
6.8.3.6	5	150	100	0	0	0	39	-54	-93	40	-60	-100		
6.8.3.7	5	180	100	0	0	0	40	-55	-95	40	-60	-100		
Avg							38.0	-55.0	-93.1	39.3	-60.0	-99.3		
Median							39.0	-55.0	-93.0	39.0	-60.0	-99.0		
Std Dev							1.8	1.2	1.1	1.6	1.3	0.8		
Mode							39.0	-54.0	-93.0	39.0	-60.0	-99.0		

ECT Phase 2 – Vol. 2 – Appendices

6.8.4.1	10	0	100	0	0	0	36	-58	-94	35	-64	-99	
6.8.4.2	10	30	100	0	0	0	35	-57	-92	35	-63	-97	
6.8.4.3	10	60	100	0	0	0	23	-58	-80	33	-64	-97	
6.8.4.4	10	90	100	0	0	0	39	-56	-95	35	-64	-99	
6.8.4.5	10	120	100	0	0	0	39	-56	-95	34	-65	-97	
6.8.4.6	10	150	100	0	0	0	35	-58	-93	36	-64	-99	
6.8.4.7	10	180	100	0	0	0	32	-57	-91	34	-64	-97	
Avg							34.1	-57.1	-91.4	34.6	-64.0	-97.9	
Median							35.0	-57.0	-93.0	35.0	-64.0	-97.0	
Std Dev							5.5	0.9	5.3	1.0	0.6	1.1	
Mode							35.0	-58.0	-95.0	35.0	-64.0	-97.0	
6.8.5.1	15	0	100	0	0	0	37	-58	-94	35	-64	-99	
6.8.5.2	15	30	100	0	0	0	35	-58	-93	34	-63	-98	
6.8.5.3	15	60	100	0	0	0	36	-58	-94	33	-65	-98	
6.8.5.4	15	90	100	0	0	0	32	-59	-92	34	-64	-100	
6.8.5.5	15	120	100	0	0	0	35	-59	-95	34	-63	-100	
6.8.5.6	15	150	100	0	0	0	37	-59	-95	35	-64	-100	
6.8.5.7	15	180	100	0	0	0	35	-58	-94	35	-64	-100	
Avg							35.3	-58.4	-93.9	34.3	-63.9	-99.3	
Median							35.0	-58.0	-94.0	34.0	-64.0	-100.0	
Std Dev							1.7	0.5	1.1	0.8	0.7	1.0	
Mode							35.0	-58.0	-94.0	35.0	-64.0	-100.0	
6.8.6.1	20	0	100	0	0	0	43	-50	-92	45	-55	-100	
6.8.6.2	20	30	100	0	0	0	46	-50	-94	46	-54	-100	
6.8.6.3	20	60	100	0	0	0	44	-50	-92	45	-54	-100	
6.8.6.4	20	90	100	0	0	0	41	-50	-91	43	-56	-100	
6.8.6.5	20	120	100	0	0	0	43	-50	-94	44	-56	-100	
6.8.6.6	20	150	100	0	0	0	40	-51	-91	44	-56	-100	
6.8.6.7	20	180	100	0	0	0	43	-50	-95	43	-56	-99	
Avg							42.9	-50.1	-92.7	44.3	-55.3	-99.9	
Median							43.0	-50.0	-92.0	44.0	-56.0	-100.0	
Std Dev							2.0	0.4	1.6	1.1	1.0	0.4	
Mode							43.0	-50.0	-92.0	45.0	-56.0	-100.0	
6.8.7.1	23	0	100	0	0	0	33	-58	-90	35	-64	-99	
6.8.7.2	23	30	100	0	0	0	34	-58	-93	35	-64	-100	
6.8.7.3	23	60	100	0	0	0	32	-59	-92	35	-64	-100	
6.8.7.4	23	90	100	0	0	0	33	-60	-91	34	-65	-100	
6.8.7.5	23	120	100	0	0	0	32	-59	-92	33	-65	-98	
6.8.7.6	23	150	100	0	0	0	37	-59	-5	33	-65	-99	
6.8.7.7	23	180	100	0	0	0	35	-59	-95	33	-65	-100	
Avg							33.7	-58.9	-79.7	34.0	-64.6	-99.4	
Median							33.0	-59.0	-92.0	34.0	-65.0	-100.0	
Std Dev							1.8	0.7	33.0	1.0	0.5	0.8	
Mode							33.0	-59.0	-92.0	35.0	-65.0	-100.0	

Summary													
Run	X	Time	LT	BS			Laptop			Base station			Comments
	Ft	Sec	BL	BL			SNR	Signal	Noise	SNR	Signal	Noise	
								dB	dB		dB	dB	
6.8.1	0		41.1	42.1									
6.8.2	2		41.1	42.1			38.1	-55.3	-93.4	39.1	-59.9	-99.3	
6.8.3	5		41.1	42.1			38.0	-55.0	-93.1	39.3	-60.0	-99.3	
6.8.4	10		41.1	42.1			34.1	-57.1	-91.4	34.6	-64.0	-97.9	
6.8.5	15		41.1	42.1			35.3	-58.4	-93.9	34.3	-63.9	-99.3	
6.8.6	20		41.1	42.1			42.9	-50.1	-92.7	44.3	-55.3	-99.9	
6.8.7	23		41.1	42.1			33.7	-58.9	-79.7	34.0	-64.6	-99.4	
6.8.8	25		41.1	42.1									

T-6.8: WiFi SNR With CB (3h, 2 w, 1 t)

6.9 TEST 6.9: WI-FI PERFORMANCE WITH HUMAN BARRIER

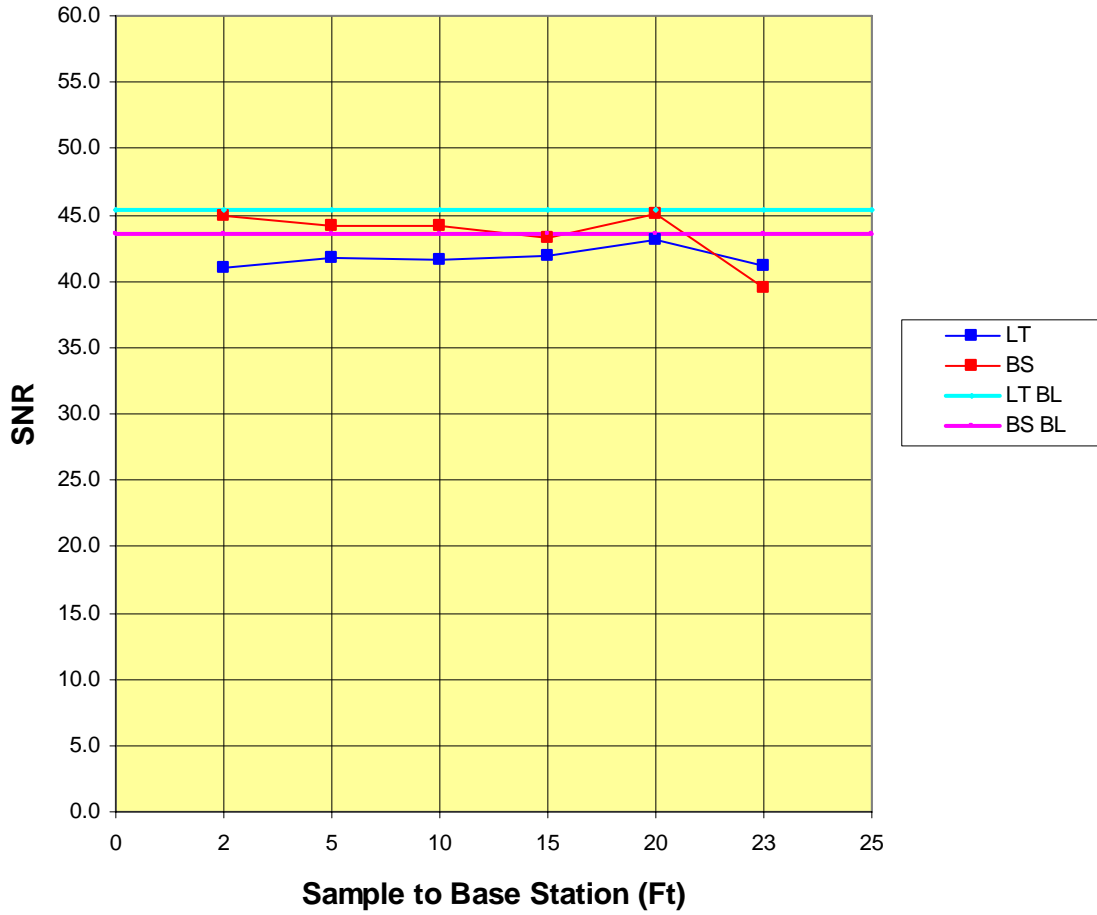
WiFi Performance With Human Barrier													
Test	6.9												
Date	4/15/03			Time	800								
Location			EDL Advanced Network Development Lab										
Test Coordinator:			W. Harris										
Test Personnel:			Bill Haskell										
Hardware:			Laptop #BH			Base station:			EDL-lab 1				
Address:			00-02-2D-6E-A2-F4				00-50-F2-C7-21-6C						
Encryption (WEP):			128 bit			Firewall:			on	Pings:	Open		
Test Equipment:			Laptop built-in measuring software							Cal:	new		
Antenna:		Rear-12:00 (Vertical)											
Distance:		25 ft											
Barrier		1 Male, 215 lbs, 6'2"											
Run	X	Time	Transmission				Laptop			Base station			Comments
	Ft	Sec	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	
			11	5.5	2	1		dB	dB		dB	dB	
6.9.1.1	NA	0	100	0	0	0	43	-49	-93	43	-54	-98	Baseline
6.9.1.2	NA	30	100	0	0	0	43	-49	-93	44	-54	-98	
6.9.1.3	NA	60	100	0	0	0	46	-48	-94	43	-54	-98	
6.9.1.4	NA	90	100	0	0	0	46	-48	-94	43	-54	-98	
6.9.1.5	NA	120	100	0	0	0	47	-48	-96	44	-54	-98	
6.9.1.6	NA	150	100	0	0	0	46	-49	-94	45	-54	-98	
6.9.1.7	NA	180	100	0	0	0	47	-49	-95	43	-54	-98	
Avg							45.4	-48.6	-94.1	43.6	-54.0	-98.0	
Median							46.0	-49.0	-94.0	43.0	-54.0	-98.0	
Std Dev							1.7	0.5	1.1	0.8	0.0	0.0	
Mode							46.0	-49.0	-94.0	43.0	-54.0	-98.0	
6.9.2.1	2	0	100	0	0	0	38	-53	-91	46	-54	-98	
6.9.2.2	2	30	100	0	0	0	40	-54	-94	44	-54	-98	
6.9.2.3	2	60	100	0	0	0	44	-53	-98	45	-54	-98	
6.9.2.4	2	90	100	0	0	0	39	-53	-92	46	-53	-98	
6.9.2.5	2	120	100	0	0	0	44	-52	-97	45	-52	-97	
6.9.2.6	2	150	100	0	0	0	41	-52	-94	44	-53	-98	
6.9.2.7	2	180	100	0	0	0	41	-53	-93	45	-54	-98	
Avg							41.0	-52.9	-94.1	45.0	-53.4	-97.9	
Median							41.0	-53.0	-94.0	45.0	-54.0	-98.0	
Std Dev							2.3	0.7	2.5	0.8	0.8	0.4	
Mode							44.0	-53.0	-94.0	45.0	-54.0	-98.0	
6.9.4.1	5	0	100	0	0	0	39	-54	-93	45	-54	-98	
6.9.4.2	5	30	100	0	0	0	40	-53	-93	44	-54	-97	
6.9.4.3	5	60	100	0	0	0	45	-52	-98	45	-54	-97	
6.9.4.4	5	90	100	0	0	0	41	-52	-92	44	-54	-97	
6.9.4.5	5	120	100	0	0	0	41	-52	-92	44	-54	-98	
6.9.4.6	5	150	100	0	0	0	44	-52	-96	44	-56	-98	
6.9.4.7	5	180	100	0	0	0	42	-54	-95	43	-54	-98	
Avg							41.7	-52.7	-94.1	44.1	-54.3	-97.6	
Median							41.0	-52.0	-93.0	44.0	-54.0	-98.0	
Std Dev							2.1	1.0	2.3	0.7	0.8	0.5	
Mode							41.0	-52.0	-93.0	44.0	-54.0	-98.0	

ECT Phase 2 – Vol. 2 – Appendices

6.9.3.1	10	0	100	0	0	0	41	-52	-93	43	-54	-98	
6.9.3.2	10	30	100	0	0	0	40	-53	-94	44	-54	-98	
6.9.3.3	10	60	100	0	0	0	43	-53	-96	46	-54	-98	
6.9.3.4	10	90	100	0	0	0	42	-53	-95	45	-54	-98	
6.9.3.5	10	120	100	0	0	0	41	-53	-94	44	-54	-98	
6.9.3.6	10	150	100	0	0	0	41	-53	-94	44	-54	-98	
6.9.3.7	10	180	100	0	0	0	43	-54	-96	43	-54	-98	
Avg							41.6	-53.0	-94.6	44.1	-54.0	-98.0	
Median							41.0	-53.0	-94.0	44.0	-54.0	-98.0	
Std Dev							1.1	0.6	1.1	1.1	0.0	0.0	
Mode							41.0	-53.0	-94.0	44.0	-54.0	-98.0	
6.9.5.1	15	0	100	0	0	0	43	-51	-94	43	-54	-98	
6.9.5.2	15	30	100	0	0	0	45	-51	-97	42	-55	-98	
6.9.5.3	15	60	100	0	0	0	39	-52	-91	43	-54	-98	
6.9.5.4	15	90	100	0	0	0	45	-52	-97	43	-54	-97	
6.9.5.5	15	120	100	0	0	0	39	-52	-91	44	-54	-97	
6.9.5.6	15	150	100	0	0	0	41	-52	-92	44	-54	-98	
6.9.5.7	15	180	100	0	0	0	41	-50	-91	44	-54	-98	
Avg							41.9	-51.4	-93.3	43.3	-54.1	-97.7	
Median							41.0	-52.0	-92.0	43.0	-54.0	-98.0	
Std Dev							2.5	0.8	2.8	0.8	0.4	0.5	
Mode							45.0	-52.0	-91.0	43.0	-54.0	-98.0	
6.9.6.1	20	0	100	0	0	0	42	-51	-94	45	-54	-98	
6.9.6.2	20	30	100	0	0	0	43	-50	-92	44	-54	-98	
6.9.6.3	20	60	100	0	0	0	43	-51	-93	46	-53	-98	
6.9.6.4	20	90	100	0	0	0	45	-50	-95	45	-54	-98	
6.9.6.5	20	120	100	0	0	0	42	-51	-92	45	-54	-98	
6.9.6.6	20	150	100	0	0	0	44	-49	-94	46	-54	-98	
6.9.6.7	20	180	100	0	0	0	43	-50	-94	45	-54	-98	
Avg							43.1	-50.3	-93.4	45.1	-53.9	-98.0	
Median							43.0	-50.0	-94.0	45.0	-54.0	-98.0	
Std Dev							1.1	0.8	1.1	0.7	0.4	0.0	
Mode							43.0	-51.0	-94.0	45.0	-54.0	-98.0	
6.9.7.1	23	0	100	0	0	0	38	-53	-92	40	-57	-98	
6.9.7.2	23	30	100	0	0	0	42	-53	-95	39	-58	-98	
6.9.7.3	23	60	100	0	0	0	44	-53	-96	40	-58	-97	
6.9.7.4	23	90	100	0	0	0	40	-53	-93	40	-58	-98	
6.9.7.5	23	120	100	0	0	0	43	-52	-95	39	-58	-98	
6.9.7.6	23	150	100	0	0	0	41	-52	-95	39	-58	-98	
6.9.7.7	23	180	100	0	0	0	40	-52	-93	40	-58	-98	
Avg							41.1	-52.6	-94.1	39.6	-57.9	-97.9	
Median							41.0	-53.0	-95.0	40.0	-58.0	-98.0	
Std Dev							2.0	0.5	1.5	0.5	0.4	0.4	
Mode							40.0	-53.0	-95.0	40.0	-58.0	-98.0	

Summary													
Run	X	Time	LT	BS			Laptop			Base station			Comments
	Ft	Sec	BL	BL			SNR	Signal	Noise	SNR	Signal	Noise	
								dB	dB		dB	dB	
6.9.1	0		45.4	43.6									
6.9.2	2		45.4	43.6			41.0	-52.9	-94.1	45.0	-53.4	-97.9	
6.9.3	5		45.4	43.6			41.7	-52.7	-94.1	44.1	-54.3	-97.6	
6.9.4	10		45.4	43.6			41.6	-53.0	-94.6	44.1	-54.0	-98.0	
6.9.5	15		45.4	43.6			41.9	-51.4	-93.3	43.3	-54.1	-97.7	
6.9.6	20		45.4	43.6			43.1	-50.3	-93.4	45.1	-53.9	-98.0	
6.9.7	23		45.4	43.6			41.1	-52.6	-94.1	39.6	-57.9	-97.9	
6.9.8	25		45.4	43.6									

T-6.9: WiFi SNR With Human Barrier



7.0 TEST 7: WI-FI PERFORMANCE WITH INTERFERENCE

7.1 TEST 7.1: WI-FI PERFORMANCE WITH UWB

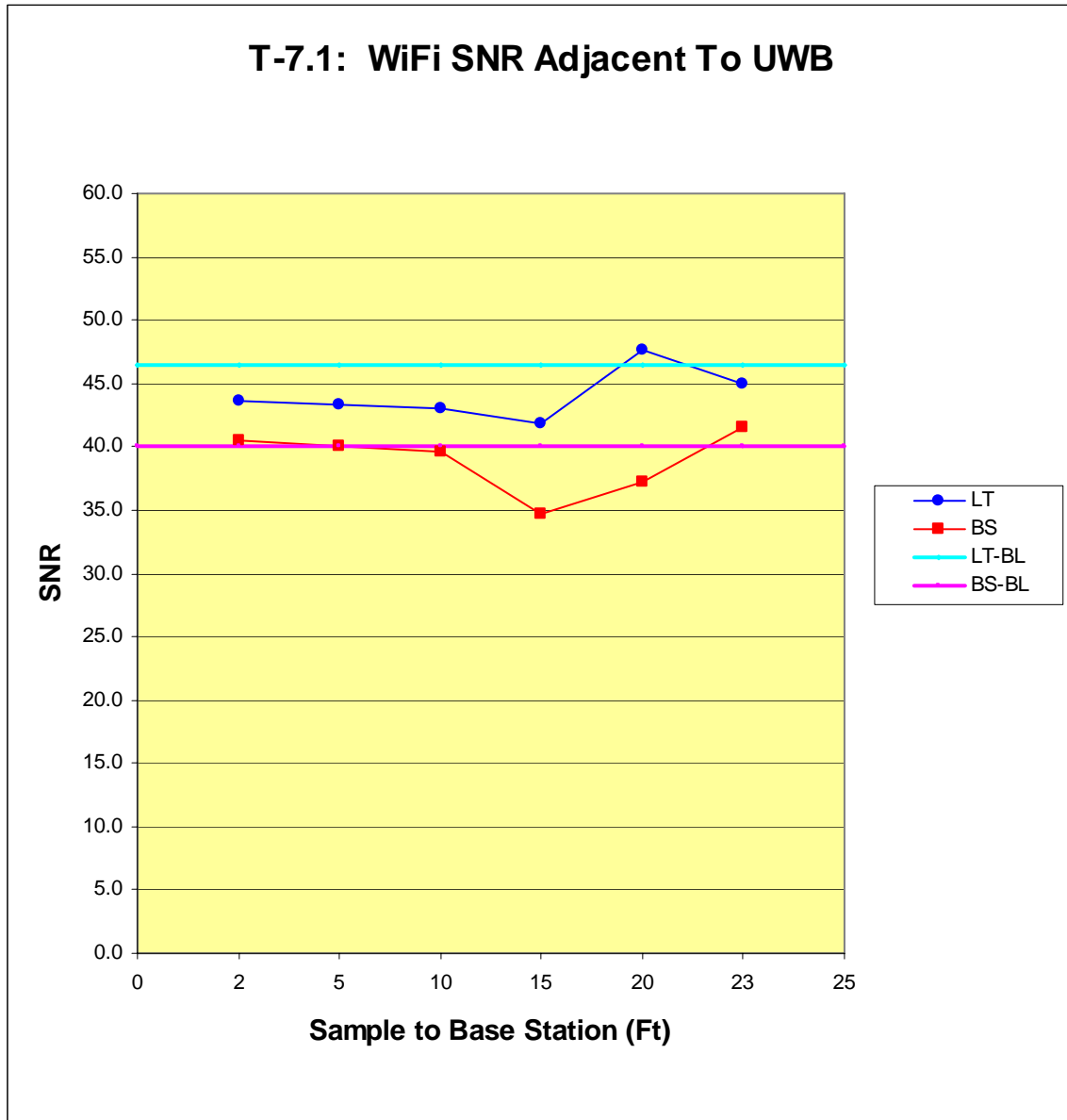
WiFi Performance Adjacent To UWB													
Test	7.1												
Date	4/15/03			Time	830								
Location				EDL Advanced Network Development Lab									
Test Coordinator:				W. Harris									
Test Personnel:				Bill Haskell									
Hardware:				Laptop #BH			Base station:		EDL-lab 1				
Address:				00-02-2D-6E-A2-F4			00-50-F2-C7-21-6C						
Encryption (WEP):				128 bit			Firewall:		on	Pings:	Open		
Test Equipment:				Laptop built-in measuring software							Cal:	new	
Antenna:				Rear-12:00 (Vertical)									
Distance:				25 ft									
Object				Ultra Wide Band Transmitter places at distances shown. UWB peer behind & above BS									
			Transmission				Laptop			Base station			Comments
Run	X	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	
	Ft	Sec	11	5.5	2	1		dB	dB		dB	dB	
7.1.1.1	NA	0	100	0	0	0	50	-48	-98	41	-56	-96	Baseline
7.1.1.2		30	100	0	0	0	46	-48	-93	40	-57	-96	No Xmtr
7.1.1.3		60	100	0	0	0	47	-47	-95	39	-58	-96	
7.1.1.4		90	100	0	0	0	46	-47	-92	40	-56	-94	
7.1.1.5		120	100	0	0	0	47	-47	-94	42	-56	-96	
7.1.1.6		150	100	0	0	0	45	-47	-93	39	-56	-95	
7.1.1.7		180	100	0	0	0	44	-47	-92	39	-57	-95	
Avg							46.4	-47.3	-93.9	40.0	-56.6	-95.4	
Median							46.0	-47.0	-93.0	40.0	-56.0	-96.0	
Std Dev							1.9	0.5	2.1	1.2	0.8	0.8	
Mode							46.0	-47.0	-93.0	39.0	-56.0	-96.0	
7.1.2.1	2	0	100	0	0	0	43	-48	-91	42	-56	-98	UWB Xmtr on
7.1.2.2	2	30	100	0	0	0	44	-50	-95	40	-57	-98	
7.1.2.3	2	60	100	0	0	0	42	-50	-93	40	-57	-98	
7.1.2.4	2	90	100	0	0	0	42	-51	-94	41	-56	-98	
7.1.2.5	2	120	100	0	0	0	42	-51	-93	41	-56	-98	
7.1.2.6	2	150	100	0	0	0	45	-50	-94	41	-56	-97	
7.1.2.7	2	180	100	0	0	0	47	-51	-97	38	-59	-98	
Avg							43.6	-50.1	-93.9	40.4	-56.7	-97.9	
Median							43.0	-50.0	-94.0	41.0	-56.0	-98.0	
Std Dev							1.9	1.1	1.9	1.3	1.1	0.4	
Mode							42.0	-50.0	-93.0	41.0	-56.0	-98.0	

ECT Phase 2 – Vol. 2 – Appendices

7.1.3.1	5	0	100	0	0	0	43	-49	-94	42	-57	-98	UWB Xmtr on
7.1.3.2	5	30	100	0	0	0	42	-50	-94	41	-57	-97	
7.1.3.3	5	60	100	0	0	0	46	-51	-96	40	-57	-95	
7.1.3.4	5	90	100	0	0	0	42	-51	-93	39	-58	-97	
7.1.3.5	5	120	100	0	0	0	42	-51	-95	38	-59	-98	
7.1.3.6	5	150	100	0	0	0	41	-52	-92	39	-58	-98	
7.1.3.7	5	180	100	0	0	0	47	-51	-98	41	-58	-98	
Avg							43.3	-50.7	-94.6	40.0	-57.7	-97.3	
Median							42.0	-51.0	-94.0	40.0	-58.0	-98.0	
Std Dev							2.3	1.0	2.0	1.4	0.8	1.1	
Mode							42.0	-51.0	-94.0	41.0	-57.0	-98.0	
7.1.4.1	10	0	100	0	0	0	45	-50	-95	39	-58	-97	UWB Xmtr on
7.1.4.2	10	30	100	0	0	0	46	-52	-98	40	-57	-98	
7.1.4.3	10	60	100	0	0	0	42	-53	-95	39	-58	-98	
7.1.4.4	10	90	100	0	0	0	39	-52	-92	39	-58	-98	
7.1.4.5	10	120	100	0	0	0	40	-51	-92	40	-58	-98	
7.1.4.6	10	150	100	0	0	0	43	-51	-94	40	-58	-98	
7.1.4.7	10	180	100	0	0	0	46	-50	-96	40	-57	-98	
Avg							43.0	-51.3	-94.6	39.6	-57.7	-97.9	
Median							43.0	-51.0	-95.0	40.0	-58.0	-98.0	
Std Dev							2.8	1.1	2.1	0.5	0.5	0.4	
Mode							46.0	-50.0	-95.0	40.0	-58.0	-98.0	
7.1.5.1	15	0	100	0	0	0	41	-53	-94	35	-62	-98	UWB Xmtr on
7.1.5.2	15	30	100	0	0	0	39	-53	-95	35	-62	-97	
7.1.5.3	15	60	100	0	0	0	37	-55	-92	34	-63	-98	
7.1.5.4	15	90	100	0	0	0	43	-51	-95	34	-62	-95	
7.1.5.5	15	120	100	0	0	0	46	-50	-95	36	-61	-97	
7.1.5.6	15	150	100	0	0	0	44	-50	-94	34	-63	-96	
7.1.5.7	15	180	100	0	0	0	43	-51	-94	35	-62	-98	
Avg							41.9	-51.9	-94.1	34.7	-62.1	-97.0	
Median							43.0	-51.0	-94.0	35.0	-62.0	-97.0	
Std Dev							3.1	1.9	1.1	0.8	0.7	1.2	
Mode							43.0	-53.0	-94.0	35.0	-62.0	-98.0	

ECT Phase 2 – Vol. 2 – Appendices

7.1.6.1	20	0	100	0	0	0	49	-46	-95	36	-61	-98	UWB Xmtr on
7.1.6.2	20	30	100	0	0	0	49	-47	-95	38	-59	-98	
7.1.6.3	20	60	100	0	0	0	47	-46	-93	39	-59	-98	
7.1.6.4	20	90	100	0	0	0	47	-48	-95	37	-60	-98	
7.1.6.5	20	120	100	0	0	0	48	-48	-96	38	-59	-98	
7.1.6.6	20	150	100	0	0	0	47	-48	-95	36	-61	-98	
7.1.6.7	20	180	100	0	0	0	46	-48	-95	37	-60	-98	
Avg							47.6	-47.3	-94.9	37.3	-59.9	-98.0	
Median							47.0	-48.0	-95.0	37.0	-60.0	-98.0	
Std Dev							1.1	1.0	0.9	1.1	0.9	0.0	
Mode							47.0	-48.0	-95.0	36.0	-59.0	-98.0	
7.1.7.1	23	0	100	0	0	0	43	-51	-93	40	-57	-98	
7.1.7.2	23	30	100	0	0	0	45	-50	-95	40	-58	-98	
7.1.7.3	23	60	100	0	0	0	46	-50	-96	41	-56	-98	
7.1.7.4	23	90	100	0	0	0	45	-51	-97	42	-56	-98	
7.1.7.5	23	120	100	0	0	0	42	-51	-93	42	-56	-98	
7.1.7.6	23	150	100	0	0	0	48	-52	-99	42	-55	-98	
7.1.7.7	23	180	100	0	0	0	44	-52	-95	42	-55	-98	
Avg							45.0	-51.0	-95.8	41.5	-56.0	-98.0	
Median							45.0	-51.0	-95.5	41.5	-56.0	-98.0	
Std Dev							2.1	0.8	2.3	1.0	1.0	0.0	
Mode							45.0	-51.0	-93.0	42.0	-56.0	-98.0	
Summary													
							Laptop			Base station			Comments
Run	X	Time	LT	BS			SNR	Signal	Noise	SNR	Signal	Noise	
	Ft	Sec	BL	BL				dB	dB		dB	dB	
7.1.1	0		46.4	40.0									
7.1.2	2		46.4	40.0			43.6	-50.1	-93.9	40.4	-56.7	-97.9	
7.1.3	5		46.4	40.0			43.3	-50.7	-94.6	40.0	-57.7	-97.3	
7.1.4	10		46.4	40.0			43.0	-51.3	-94.6	39.6	-57.7	-97.9	
7.1.5	15		46.4	40.0			41.9	-51.9	-94.1	34.7	-62.1	-97.0	
7.1.6	20		46.4	40.0			47.6	-47.3	-94.9	37.3	-59.9	-98.0	
7.1.7	23		46.4	40.0			45.0	-51.0	-95.8	41.5	-56.0	-98.0	
7.1.8	25		46.4	40.0									



7.2

TEST 7.2: WI-FI PERFORMANCE WITH MICROWAVE OVEN

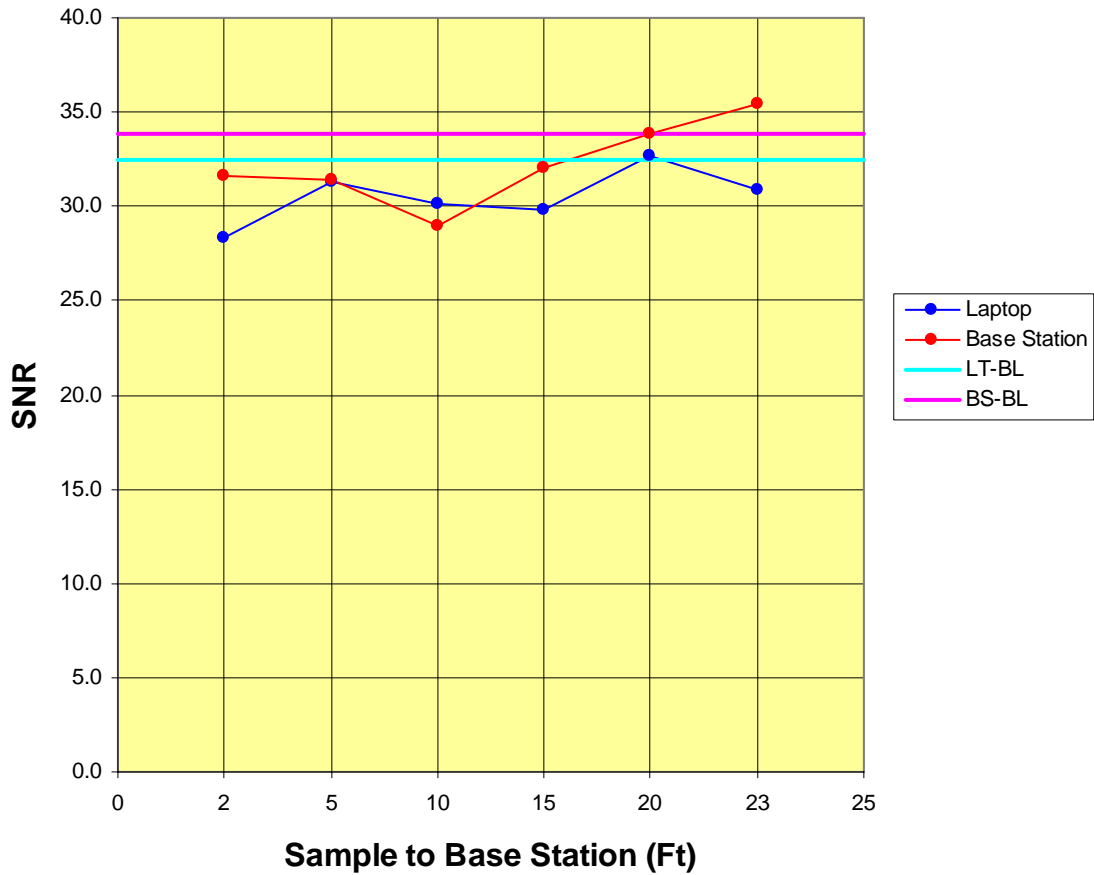
WiFi Performance Adjacent To Microwave Oven														
Test	7.2													
Date				Time										
Location				Melbourne: Wickham & Lk Washington										
Test Coordinator:				W. Harris										
Test Personnel:				none										
Hardware:				Laptop #BH			Base station:			EDL-lab 1				
Address:				00-02-2D-6E-A2-F4			00-50-F2-C7-21-6C							
Encryption (WEP):				128 bit			Firewall:		on	Pings:		Open		
Test Equipment:				Laptop built-in measuring software							Cal:	new		
Antenna:				Rear-12:00 (Vertical)										
Distance:				25 ft										
Object				900W Microwave Oven, 2.45 GHz, Magic Chef model MCD990SC										
			Transmission				Laptop			Base station			Comments	
Run	X	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise		
	Ft	Sec	11	5.5	2	1		dB	dB		dB	dB		
7.2.1.1	NA	0	100	0	0	0	33	-62	-95	34	-65	-100	Baseline	
7.2.1.2		30	100	0	0	0	33	-62	-95	34	-65	-100	Oven off	
7.2.1.3		60	100	0	0	0	32	-61	-95	34	-65	-100		
7.2.1.4		90	100	0	0	0	33	-63	-95	34	-66	-100		
7.2.1.5		120	100	0	0	0	32	-63	-95	33	-66	-100		
7.2.1.6		150	100	0	0	0	35	-62	-97	34	-65	-100		
7.2.1.7		180	100	0	0	0	29	-61	-90	34	-65	-100		
Avg							32.4	-62.0	-94.6	33.9	-65.3	-100.0		
Median							33.0	-62.0	-95.0	34.0	-65.0	-100.0		
Std Dev							1.8	0.8	2.1	0.4	0.5	0.0		
Mode							33.0	-62.0	-95.0	34.0	-65.0	-100.0		
7.2.2.1	2	0	100	0	0	0	22	-61	-83	23	-66	-90	Oven on	
7.2.2.2	2	30	100	0	0	0	28	-61	-89	33	-66	-97		
7.2.2.3	2	60	100	0	0	0	30	-61	-92	33	-66	-98		
7.2.2.4	2	90	100	0	0	0	31	-62	-93	33	-65	-98		
7.2.2.5	2	120	100	0	0	0	32	-63	-94	31	-65	-97		
7.2.2.6	2	150	100	0	0	0	33	-62	-93	33	-64	-97		
7.2.2.7	2	180	100	0	0	0	22	-62	-94	35	-64	-97		
Avg							28.3	-61.7	-91.1	31.6	-65.1	-96.3		
Median							30.0	-62.0	-93.0	33.0	-65.0	-97.0		
Std Dev							4.6	0.8	4.0	4.0	0.9	2.8		
Mode							22.0	-61.0	-93.0	33.0	-66.0	-97.0		
7.2.3.1	5	0	100	0	0	0	26	-63	-90	31	-67	-97	Oven on	
7.2.3.2	5	30	100	0	0	0	30	-64	-93	32	-66	-97		
7.2.3.3	5	60	100	0	0	0	34	-63	-96	27	-67	-94		
7.2.3.4	5	90	100	0	0	0	37	-62	-99	34	-66	-98		
7.2.3.5	5	120	100	0	0	0	29	-63	-93	31	-67	-98		
7.2.3.6	5	150	100	0	0	0	34	-62	-96	31	-66	-97		
7.2.3.7	5	180	100	0	0	0	29	-62	-91	34	-66	-98		
Avg							31.3	-62.7	-94.0	31.4	-66.4	-97.0		
Median							30.0	-63.0	-93.0	31.0	-66.0	-97.0		
Std Dev							3.8	0.8	3.2	2.4	0.5	1.4		
Mode							34.0	-63.0	-93.0	31.0	-66.0	-97.0		

ECT Phase 2 – Vol. 2 – Appendices

7.2.4.1	10	0	100	0	0	0	33	-63	-95	32	-67	-98	Oven on
7.2.4.2	10	30	98	1	0	0	29	-63	-93	20	-67	-87	Speed changing
7.2.4.3	10	60	98	1	0	0	29	-66	-95	31	-68	-98	
7.2.4.4	10	90	98	1	0	0	33	-66	-97	31	-68	-97	
7.2.4.5	10	120	98	1	0	0	28	-66	-92	31	-68	-97	
7.2.4.6	10	150	99	1	0	0	27	-66	-91	28	-68	-95	
7.2.4.7	10	180	100	0	0	0	32	-66	-97	30	-68	-98	
Avg							30.1	-65.1	-94.3	29.0	-67.7	-95.7	
Median							29.0	-66.0	-95.0	31.0	-68.0	-97.0	
Std Dev							2.5	1.5	2.4	4.2	0.5	4.0	
Mode							33.0	-66.0	-95.0	31.0	-68.0	-98.0	
7.2.5.1	15	0	100	0	0	0	24	-65	-89	27	-66	-93	Oven on
7.2.5.2	15	30	100	0	0	0	31	-64	-94	33	-66	-97	
7.2.5.3	15	60	100	0	0	0	30	-64	-93	33	-66	-100	
7.2.5.4	15	90	100	0	0	0	32	-64	-96	33	-66	-100	
7.2.5.5	15	120	100	0	0	0	29	-63	-92	33	-66	-100	
7.2.5.6	15	150	100	0	0	0	32	-63	-96	32	-67	-100	
7.2.5.7	15	180	100	0	0	0	31	-64	-95	33	-66	-100	
Avg							29.9	-63.9	-93.6	32.0	-66.1	-98.6	
Median							31.0	-64.0	-94.0	33.0	-66.0	-100.0	
Std Dev							2.8	0.7	2.5	2.2	0.4	2.7	
Mode							31.0	-64.0	-96.0	33.0	-66.0	-100.0	
7.2.6.1	20	0	100	0	0	0	25	-66	-89	33	67	-98	Oven on
7.2.6.2	20	30	100	0	0	0	35	-60	-95	35	-64	-99	
7.2.6.3	20	60	100	0	0	0	35	-61	-64	33	-66	-97	
7.2.6.4	20	90	98	2	0	0	37	-60	-97	35	-64	-99	Speed changing
7.2.6.5	20	120	99	0	0	0	33	-61	-93	34	-64	-97	
7.2.6.6	20	150	99	0	0	0	31	-62	-93	33	-65	-98	
7.2.6.7	20	180	100	0	0	0	33	-61	-94	34	-65	-99	
Avg							32.7	-61.6	-89.3	33.9	-45.9	-98.0	
Median							33.0	-61.0	-93.0	34.0	-64.0	-98.0	
Std Dev							3.9	2.1	11.4	0.9	49.8	1.0	
Mode							35.0	-61.0	-93.0	33.0	-64.0	-97.0	
7.2.7.1	23	0	98	1	0	0	30	-61	-92	36	-63	-100	Oven on
7.2.7.2	23	30	98	1	0	0	29	-63	-91	34	-64	-98	Speed changing
7.2.7.3	23	60	97	2	0	0	31	-64	-95	33	-64	-97	
7.2.7.4	23	90	97	2	0	0	31	-63	-94	36	-64	-98	
7.2.7.5	23	120	98	1	0	0	29	-63	-91	36	-64	-98	
7.2.7.6	23	150	97	2	0	0	34	-61	-94	37	-62	-98	
7.2.7.7	23	180	97	2	0	0	32	-61	-92	36	-63	-97	
Avg							30.9	-62.3	-92.7	35.4	-63.4	-97.6	
Median							31.0	-63.0	-92.0	36.0	-64.0	-98.0	
Std Dev							1.8	1.3	1.6	1.4	0.8	0.5	
Mode							29.0	-61.0	-92.0	36.0	-64.0	-98.0	

Summary													
Run	X	Time	LT	BS			Laptop			Base station			Comments
	Ft	Sec	BL	BL			SNR	Signal	Noise	SNR	Signal	Noise	
								dB	dB		dB	dB	
7.2.1	0		32.4	33.9									
7.2.2	2		32.4	33.9			28.3	-61.7	-91.1	31.6	-65.1	-96.3	
7.2.3	5		32.4	33.9			31.3	-62.7	-94.0	31.4	-66.4	-97.0	
7.2.4	10		32.4	33.9			30.1	-65.1	-94.3	29.0	-67.7	-95.7	
7.2.5	15		32.4	33.9			29.9	-63.9	-93.6	32.0	-66.1	-98.6	
7.2.6	20		32.4	33.9			32.7	-61.6	-89.3	33.9	-45.9	-98.0	
7.2.7	23		32.4	33.9			30.9	-62.3	-92.7	35.4	-63.4	-97.6	
7.2.8	25		32.4	33.9									

T-7.2: WiFi Performance Adjacent To Microwave Oven



7.3 TEST 7.3: WI-FI PERFORMANCE WITH 2.4 GHZ CORDLESS PHONE

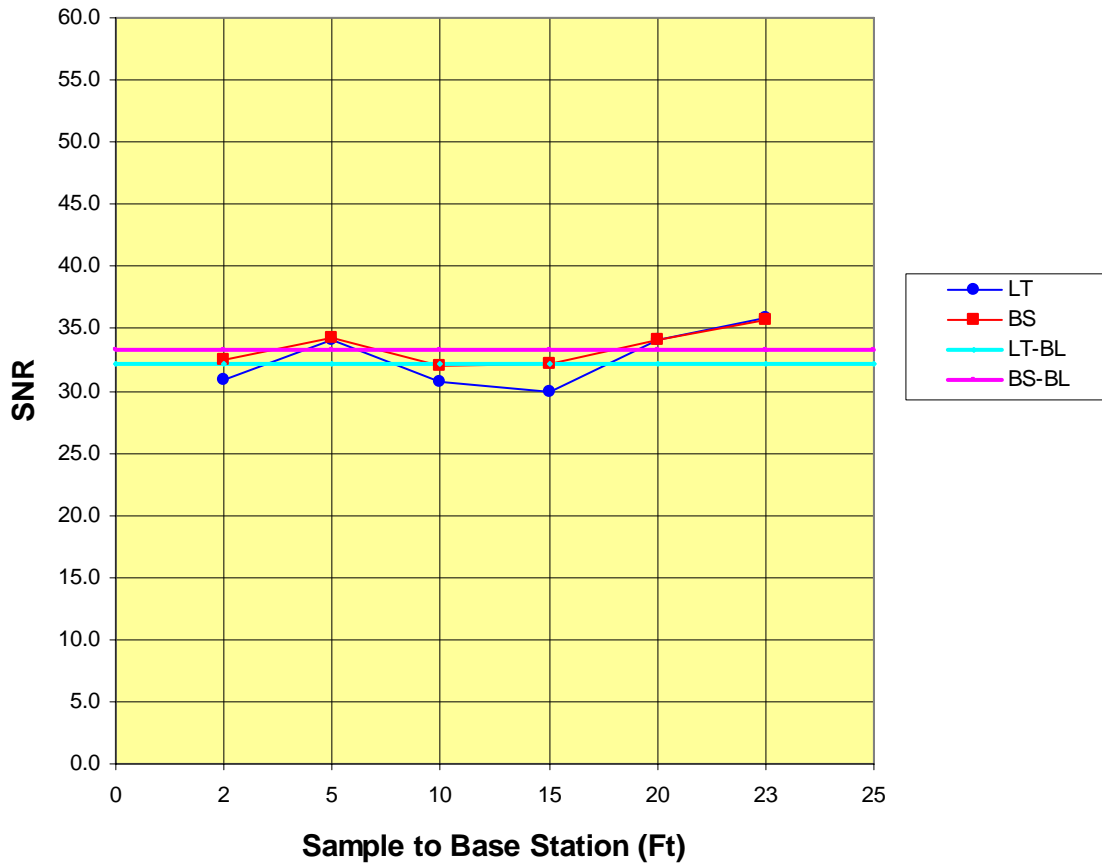
WiFi Performance Adjacent To 2.4 GHz Cordless Phone													
Test	7.3												
Date				Time									
Location				Melbourne: Wickham & Lk Washington									
Test Coordinator:				W. Harris									
Test Personnel:													
Hardware:				Laptop #BH			Base station:			EDL-lab1			
Address:				00-02-2D-6E-A2-F4			00-50-F2-C7-21-6C						
Encryption (WEP):				128 bit			Firewall:		on	Pings:		Open	
Test Equipment:				Laptop built-in measuring software						Cal:		new	
Antenna:				Rear-12:00 (Vertical)									
Distance:				25 ft									
Object				Panasonic 2.4 GHz Digital Cordless Phone, Model KX-TG2237									
				Transmission			Laptop			Base station			Comments
Run	X	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	
	Ft	Sec	11	5.5	2	1		dB	dB		dB	dB	
7.3.1.1	NA	0	100	0	0	0	31	-61	-91	34	-66	-101	Baseline
7.3.1.2		30	100	0	0	0	31	-62	-93	34	-66	-100	No Xmtr
7.3.1.3		60	100	0	0	0	30	-62	-92	34	-66	-100	
7.3.1.4		90	100	0	0	0	30	-62	-91	32	-66	-100	
7.3.1.5		120	100	0	0	0	33	-62	-95	33	-66	-100	
7.3.1.6		150	100	0	0	0	34	-62	-94	33	-66	-100	
7.3.1.7		180	100	0	0	0	36	-61	-97	33	-66	-100	
Avg							32.1	-61.7	-93.3	33.3	-66.0	-100.1	
Median							31.0	-62.0	-93.0	33.0	-66.0	-100.0	
Std Dev							2.3	0.5	2.2	0.8	0.0	0.4	
Mode							31.0	-62.0	-91.0	34.0	-66.0	-100.0	
7.3.2.1	2	0	100	0	0	0	33	-61	-95	32	-67	-100	Phone on
7.3.2.2	2	30	100	0	0	0	31	-61	-92	33	-66	-100	
7.3.2.3	2	60	100	0	0	0	30	-62	-93	32	-67	-100	
7.3.2.4	2	90	100	0	0	0	31	-62	-93	33	-67	-100	
7.3.2.5	2	120	100	0	0	0	30	-62	-91	34	-66	-100	
7.3.2.6	2	150	100	0	0	0	29	-62	-91	32	-67	-100	
7.3.2.7	2	180	100	0	0	0	32	-61	-94	32	-67	-100	
Avg							30.9	-61.6	-92.7	32.6	-66.7	-100.0	
Median							31.0	-62.0	-93.0	32.0	-67.0	-100.0	
Std Dev							1.3	0.5	1.5	0.8	0.5	0.0	
Mode							31.0	-62.0	-93.0	32.0	-67.0	-100.0	
7.3.3.1	5	0	100	0	0	0	37	-59	-97	34	-65	-100	Phone on
7.3.3.2	5	30	100	0	0	0	32	-60	-92	35	-64	-100	
7.3.3.3	5	60	100	0	0	0	35	-60	-94	34	-65	-100	
7.3.3.4	5	90	100	0	0	0	34	-60	-94	34	-65	-100	
7.3.3.5	5	120	100	0	0	0	36	-60	-95	35	-64	-100	
7.3.3.6	5	150	100	0	0	0	35	-60	-95	34	-65	-100	
7.3.3.7	5	180	100	0	0	0	30	-60	-90	34	-65	-100	

ECT Phase 2 – Vol. 2 – Appendices

Avg							34.1	-59.9	-93.9	34.3	-64.7	-100.0	
Median							35.0	-60.0	-94.0	34.0	-65.0	-100.0	
Std Dev							2.4	0.4	2.3	0.5	0.5	0.0	
Mode							35.0	-60.0	-94.0	34.0	-65.0	-100.0	
7.3.4.1	10	0	100	0	0	0	33	-62	-95	31	-67	-98	Phone on
7.3.4.2	10	30	100	0	0	0	32	-63	-96	32	-67	-98	
7.3.4.3	10	60	100	0	0	0	30	-62	-92	32	-67	-98	
7.3.4.4	10	90	100	0	0	0	31	-63	-94	32	-67	-98	
7.3.4.5	10	120	100	0	0	0	31	-63	-94	33	-66	-98	
7.3.4.6	10	150	100	0	0	0	27	-63	-92	32	-67	-100	
7.3.4.7	10	180	100	0	0	0	31	-63	-94	32	-67	-100	
Avg							30.7	-62.7	-93.9	32.0	-66.9	-98.6	
Median							31.0	-63.0	-94.0	32.0	-67.0	-98.0	
Std Dev							1.9	0.5	1.5	0.6	0.4	1.0	
Mode							31.0	-63.0	-94.0	32.0	-67.0	-98.0	
7.3.5.1	15	0	100	0	0	0	30	-62	-94	31	-67	-98	Phone on
7.3.5.2	15	30	100	0	0	0	31	-64	-96	32	-67	-98	
7.3.5.3	15	60	100	0	0	0	28	-64	-91	33	-67	-100	
7.3.5.4	15	90	100	0	0	0	32	-63	-95	32	-65	-97	
7.3.5.5	15	120	100	0	0	0	34	-63	-98	33	-66	-99	
7.3.5.6	15	150	100	0	0	0	27	-63	-91	32	-67	-99	
7.3.5.7	15	180	100	0	0	0	27	-64	-92	32	-67	-100	
Avg							29.9	-63.3	-93.9	32.1	-66.6	-98.7	
Median							30.0	-63.0	-94.0	32.0	-67.0	-99.0	
Std Dev							2.7	0.8	2.7	0.7	0.8	1.1	
Mode							27.0	-64.0	-91.0	32.0	-67.0	-98.0	
7.3.6.1	20	0	100	0	0	0	34	-62	-96	34	-66	-100	Phone on
7.3.6.2	20	30	100	0	0	0	34	-89	-95	34	-92	-100	
7.3.6.3	20	60	100	0	0	0	31	-75	-94	33	-77	-100	
7.3.6.4	20	90	100	0	0	0	34	-64	-96	34	-68	-100	
7.3.6.5	20	120	100	0	0	0	36	-60	-96	35	-64	-100	
7.3.6.6	20	150	100	0	0	0	37	-60	-97	35	-64	-100	
7.3.6.7	20	180	100	0	0	0	33	-60	-95	34	-65	-100	
Avg							34.1	-67.1	-95.6	34.1	-70.9	-100.0	
Median							34.0	-62.0	-96.0	34.0	-66.0	-100.0	
Std Dev							2.0	11.0	1.0	0.7	10.4	0.0	
Mode							34.0	-60.0	-96.0	34.0	-64.0	-100.0	
7.3.7.1	23	0	100	0	0	0	34	-57	-91	35	-64	-100	Phone on
7.3.7.2	23	30	100	0	0	0	41	-58	-97	36	-64	-100	
7.3.7.3	23	60	100	0	0	0	34	-57	-92	35	-64	-100	
7.3.7.4	23	90	100	0	0	0	32	-57	-90	36	-63	-100	
7.3.7.5	23	120	100	0	0	0	39	-58	-99	36	-63	-100	
7.3.7.6	23	150	100	0	0	0	33	-58	-91	36	-63	-100	
7.3.7.7	23	180	100	0	0	0	36	-58	-92	35	-64	-100	
Avg							35.8	-57.7	-93.5	35.7	-63.5	-100.0	
Median							34.0	-57.5	-91.5	36.0	-63.5	-100.0	
Std Dev							3.6	0.5	3.7	0.5	0.5	0.0	
Mode							34.0	-57.0	-91.0	36.0	-64.0	-100.0	

Summary													
Run	X	Time	LT	BS			Laptop			Base station			Comments
	Ft	Sec	BL	BL			SNR	Signal	Noise	SNR	Signal	Noise	
								dB	dB		dB	dB	
7.3.1	0		32.1	33.3									
7.3.2	2		32.1	33.3			30.9	-61.6	-92.7	32.6	-66.7	-100.0	
7.3.3	5		32.1	33.3			34.1	-59.9	-93.9	34.3	-64.7	-100.0	
7.3.4	10		32.1	33.3			30.7	-62.7	-93.9	32.0	-66.9	-98.6	
7.3.5	15		32.1	33.3			29.9	-63.3	-93.9	32.1	-66.6	-98.7	
7.3.6	20		32.1	33.3			34.1	-67.1	-95.6	34.1	-70.9	-100.0	
7.3.7	23		32.1	33.3			35.8	-57.7	-93.5	35.7	-63.5	-100.0	
7.3.8	25		32.1	33.3									

T-7.3: WiFi SNR Adjacent To 2.4 GHz Cordless Phone



7.4

TEST 7.4: WI-FI PERFORMANCE WITH CELL PHONE

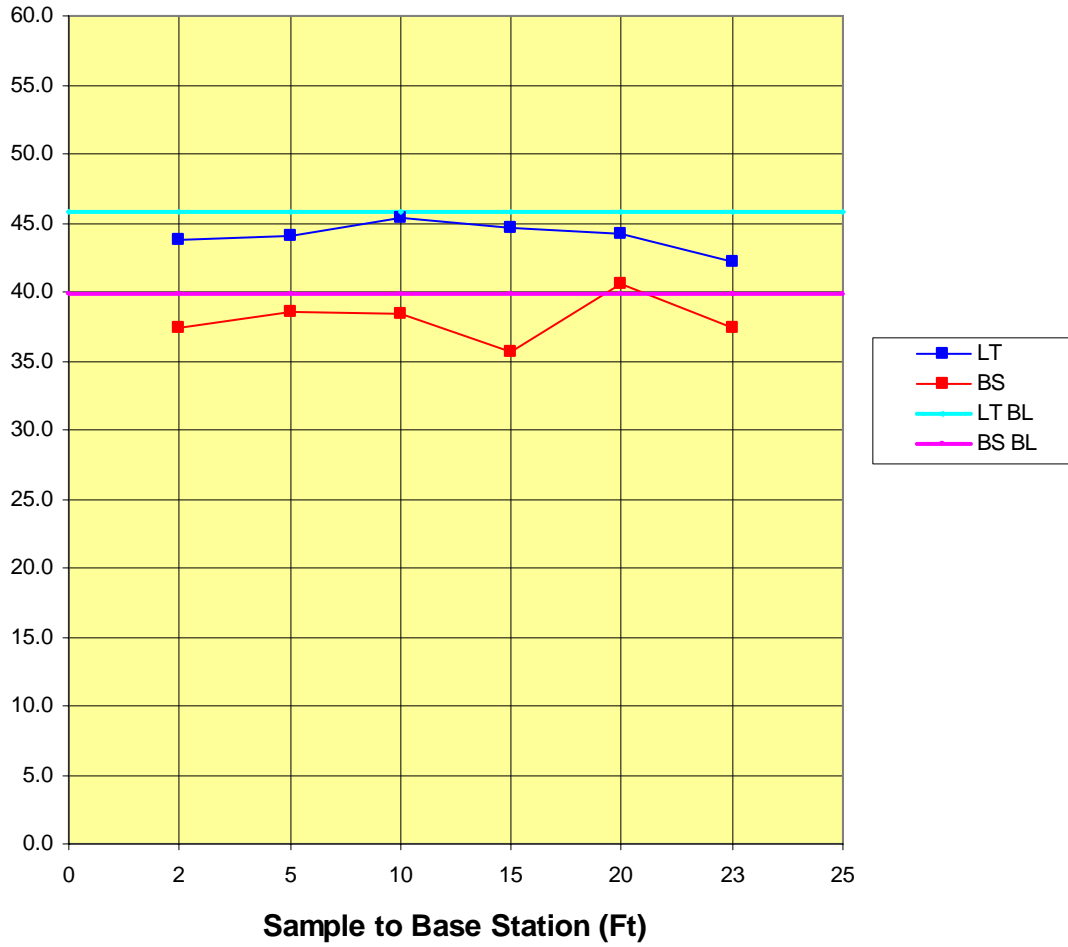
WiFi Performance Adjacent To Cell Phone														
Test	7.4													
Date	4/15/03			Time	900									
Location			EDL Advanced Network Development Lab											
Test Coordinator:			W. Harris											
Test Personnel:			none											
Hardware:			Laptop #BH				Base station: EDL-lab 1							
Address:			00-02-2D-6E-A2-F4				00-50-F2-C7-21-6C							
Encryption (WEP):			128 bit				Firewall:			on		Pings: Open		
Test Equipment:			Laptop built-in measuring software								Cal:		new	
Antenna:			Rear-12:00 (Vertical); 17.0 inches above floor											
Distance:			25 ft (Base station to Lap top) basestation antenna 17.0 inches above floor)											
Object			Cell Phone (Antenna 12.5 inches above floor); Phone receiving or in standby											
			Motorola StarTAC, Sprint											
			Transmission				Laptop			Base station			Comments	
Run	Time	X	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise		
	Sec	Ft	11	5.5	2	1		dB	dB		dB	dB		
7.4.1.1	0	NA	100	0	0	0	50	-48	-98	41	-56	-96	Baseline	
7.4.1.2	30	NA	100	0	0	0	46	-48	-93	40	-57	-96	Xmtr off	
7.4.1.3	60	NA	100	0	0	0	47	-47	-95	39	-58	-96		
7.4.1.4	90	NA	100	0	0	0	46	-47	-92	40	-56	-94		
7.4.1.5	120	NA	100	0	0	0	47	-47	-94	42	-56	-96		
7.4.1.6	150	NA	100	0	0	0	45	-47	-93	39	-56	-95		
7.4.1.7	180	NA	100	0	0	0	44	-47	-92	39	-57	-95		
Avg							45.8	-47.0	-93.2	39.8	-56.6	-95.2		
Median							46.0	-47.0	-93.0	39.0	-56.0	-95.0		
Std Dev							1.3	0.0	1.3	1.3	0.9	0.8		
Mode							47.0	-47.0	-92.0	39.0	-56.0	-96.0		
7.4.2.1	0	2	100	0	0	0	44	-52	-95	34	-63	-97		
7.4.2.2	30	2	100	0	0	0	43	-51	-94	36	-62	-98		
7.4.2.3	60	2	100	0	0	0	42	-52	-95	35	-62	-98		
7.4.2.4	90	2	100	0	0	0	48	-50	-97	40	-58	-98		
7.4.2.5	120	2	100	0	0	0	41	-51	-91	38	-59	-98		
7.4.2.6	150	2	100	0	0	0	41	-52	-93	38	-60	-98		
7.4.2.7	180	2	100	0	0	0	47	-50	-96	36	-61	-98		
Avg							43.8	-51.0	-94.4	37.4	-60.0	-98.0		
Median							42.0	-51.0	-95.0	38.0	-60.0	-98.0		
Std Dev							3.4	1.0	2.4	1.9	1.6	0.0		
Mode							41.0	-52.0	#N/A	38.0	#N/A	-98.0		
7.4.3.1	0	5	100	0	0	0	44	-50	-94	41	-56	-98		
7.4.3.2	30	5	100	0	0	0	43	-50	-92	41	-56	-98		
7.4.3.3	60	5	100	0	0	0	44	-52	-97	36	-61	-98		
7.4.3.4	90	5	100	0	0	0	46	-50	-96	40	-57	-98		
7.4.3.5	120	5	100	0	0	0	44	-50	-94	39	-58	-98		
7.4.3.6	150	5	100	0	0	0	41	-52	-93	39	-58	-98		
7.4.3.7	180	5	100	0	0	0	45	-51	-96	39	-58	-98		
Avg							44.0	-51.0	-95.2	38.6	-58.4	-98.0		
Median							44.0	-51.0	-96.0	39.0	-58.0	-98.0		
Std Dev							1.9	1.0	1.6	1.5	1.5	0.0		
Mode							44.0	-52.0	-96.0	39.0	-58.0	-98.0		

ECT Phase 2 – Vol. 2 – Appendices

7.4.4.1	0	10	100	0	0	0	43	-51	-95	34	-63	-98	
7.4.4.2	30	10	100	0	0	0	43	-51	-95	36	-61	-98	
7.4.4.3	60	10	100	0	0	0	47	-48	-95	37	-60	-98	
7.4.4.4	90	10	100	0	0	0	45	-49	-93	37	-60	-98	
7.4.4.5	120	10	100	0	0	0	43	-50	-92	38	-59	-98	
7.4.4.6	150	10	100	0	0	0	46	-48	-94	38	-59	-98	
7.4.4.7	180	10	100	0	0	0	46	-48	-94	42	-55	-98	
Avg							45.4	-48.6	-93.6	38.4	-58.6	-98.0	
Median							46.0	-48.0	-94.0	38.0	-59.0	-98.0	
Std Dev							1.5	0.9	1.1	2.1	2.1	0.0	
Mode							46.0	-48.0	-94.0	37.0	-60.0	-98.0	
7.4.5.1	0	15	100	0	0	0	47	-50	-98	41	-56	-98	
7.4.5.2	30	15	100	0	0	0	49	-50	-98	38	-61	-98	
7.4.5.3	60	15	100	0	0	0	44	-52	-96	36	-61	-98	
7.4.5.4	90	15	100	0	0	0	44	-48	-92	39	-58	-67	
7.4.5.5	120	15	100	0	0	0	44	-50	-94	36	-61	-98	
7.4.5.6	150	15	100	0	0	0	46	-50	-95	34	-63	-98	
7.4.5.7	180	15	100	0	0	0	45	-50	-93	33	-64	-98	
Avg							44.6	-50.0	-94.0	35.6	-61.4	-91.8	
Median							44.0	-50.0	-94.0	36.0	-61.0	-98.0	
Std Dev							0.9	1.4	1.6	2.3	2.3	13.9	
Mode							44.0	-50.0	#N/A	36.0	-61.0	-98.0	
7.4.6.1	0	20	100	0	0	0	46	-51	-96	38	-58	-95	
7.4.6.2	30	20	100	0	0	0	42	-50	-92	39	-60	-97	
7.4.6.3	60	20	100	0	0	0	42	-51	-93	38	-59	-65	
7.4.6.4	90	20	100	0	0	0	46	-48	-94	42	-55	-96	
7.4.6.5	120	20	100	0	0	0	46	-49	-94	42	-56	-98	
7.4.6.6	150	20	100	0	0	0	43	-49	-93	41	-56	-95	
7.4.6.7	180	20	100	0	0	0	44	-50	-94	40	-57	-97	
Avg							44.2	-49.4	-93.6	40.6	-56.6	-90.2	
Median							44.0	-49.0	-94.0	41.0	-56.0	-96.0	
Std Dev							1.8	1.1	0.5	1.7	1.5	14.1	
Mode							46.0	-49.0	-94.0	42.0	-56.0	#N/A	
7.4.7.1	0	23	100	0	0	0	47	-50	-98	42	-55	-97	
7.4.7.2	30	23	100	0	0	0	43	-51	-94	41	-57	-97	
7.4.7.3	60	23	100	0	0	0	41	-54	-96	36	-61	-95	
7.4.7.4	90	23	100	0	0	0	41	-52	-92	36	-59	-95	
7.4.7.5	120	23	100	0	0	0	44	-51	-95	38	-59	-98	
7.4.7.6	150	23	100	0	0	0	42	-51	-94	37	-60	-98	
7.4.7.7	180	23	100	0	0	0	43	-50	-93	40	-57	-98	
Avg							42.2	-51.6	-94.0	37.4	-59.2	-96.8	
Median							42.0	-51.0	-94.0	37.0	-59.0	-98.0	
Std Dev							1.3	1.5	1.6	1.7	1.5	1.6	
Mode							41.0	-51.0	#N/A	36.0	-59.0	-98.0	

Summary													
Run	X	Time	LT	BS			Laptop			Base station			Comments
	Ft	Sec	BL	BL			SNR	Signal	Noise	SNR	Signal	Noise	
								dB	dB		dB	dB	
7.4.1	0		45.8	39.8									
7.4.2	2		45.8	39.8			43.8	-51.0	-94.4	37.4	-60.0	-98.0	
7.4.3	5		45.8	39.8			44.0	-51.0	-95.2	38.6	-58.4	-98.0	
7.4.4	10		45.8	39.8			45.4	-48.6	-93.6	38.4	-58.6	-98.0	
7.4.5	15		45.8	39.8			44.6	-50.0	-94.0	35.6	-61.4	-91.8	
7.4.6	20		45.8	39.8			44.2	-49.4	-93.6	40.6	-56.6	-90.2	
7.4.7	23		45.8	39.8			42.2	-51.6	-94.0	37.4	-59.2	-96.8	
7.4.8	25		45.8	39.8									

T-7.4: WiFi Performance Adjacent To Cell Phone



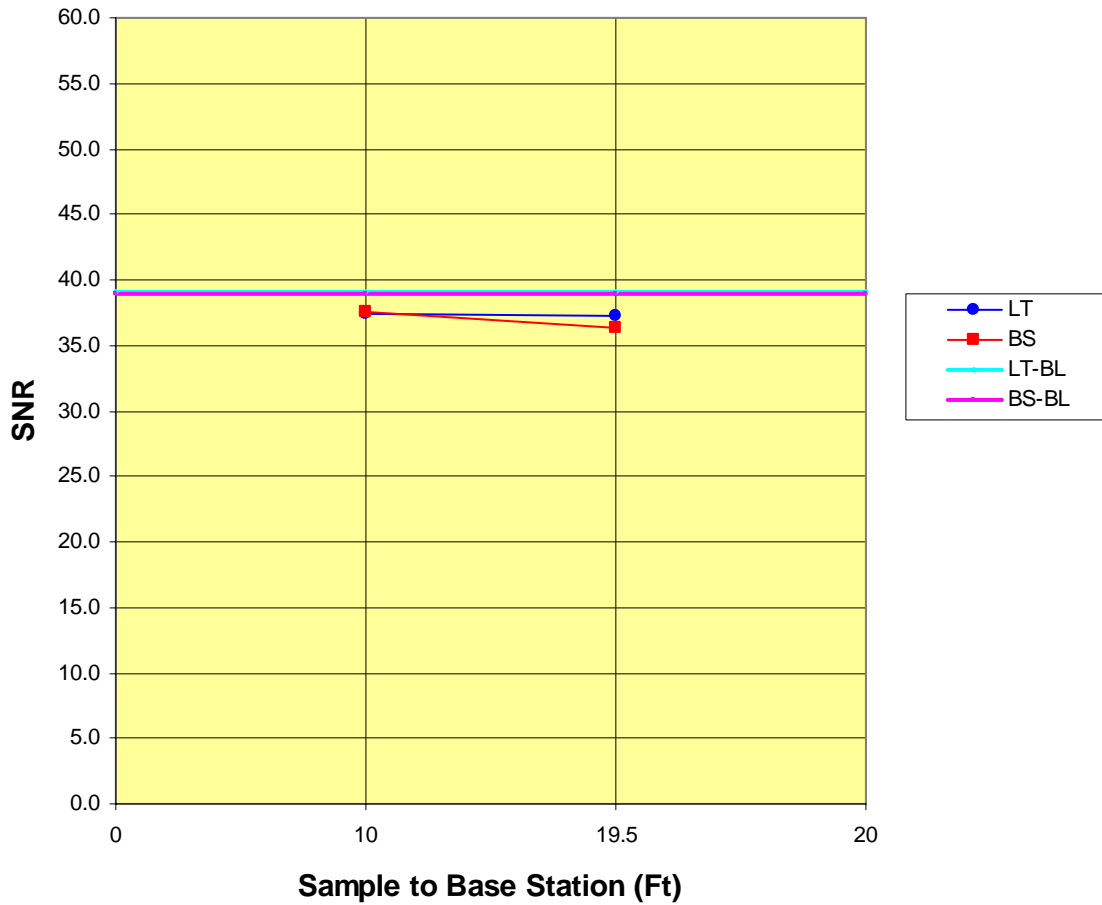
7.5 TEST 7.5: WI-FI PERFORMANCE WITH AIRCRAFT NAV RADIO

WiFi Performance Adjacent To Aircraft Nav Radio													
Test	7.5												
Date	7/8/03			Time	2225								
Location			Melbourne: Wickham & Lk Washington										
Test Coordinator:			W. Harris										
Test Personnel:			None										
Hardware:			Laptop #BH				Base station: EDL-lab1						
Address:			00-02-2D-6E-A2-F4				00-50-F2-C7-21-6C						
Encryption (WEP):			128 bit				Firewall:		on	Pings:	Open		
Test Equipment:			Laptop built-in measuring software							Cal:	new		
Antenna:			Rear-12:00 (Vertical)										
Distance:			20 ft Basestation to laptop for most runs										
Object			VHF aircraft transceiver operated in VOR receiving mode										
			Tuned to Melbourne VOR (110.0 MHz)										
			Transmission				Laptop			Base station			Comments
Run	X	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	
	Ft	Sec	11	5.5	2	1		dB	dB		dB	dB	
7.5.1.1	NA	0	100	0	0	0	39	-55	-95	38	-61	-100	Baseline
7.5.1.2		30	100	0	0	0	39	-55	-94	38	-61	-100	VHF off
7.5.1.3		60	100	0	0	0	39	-54	-93	40	-60	-100	
7.5.1.4		90	100	0	0	0	40	-55	-94	38	-61	-100	
7.5.1.5		120	100	0	0	0	39	-55	-93	40	-60	-100	
7.5.1.6		150	100	0	0	0	37	-55	-91	39	-60	-100	
7.5.1.7		180	100	0	0	0	41	-55	-95	39	-60	-100	
Avg							39.1	-54.9	-93.6	38.9	-60.4	-100.0	
Median							39.0	-55.0	-94.0	39.0	-60.0	-100.0	
Std Dev							1.2	0.4	1.4	0.9	0.5	0.0	
Mode							39.0	-55.0	-95.0	38.0	-60.0	-100.0	
7.5.2.1	10	0	100	0	0	0	40	-56	-94	39	-60	100	BS on
7.5.2.2	10	30	100	0	0	0	38	-55	-94	40	-60	-100	Receiver 10 ft
7.5.2.3	10	60	100	0	0	0	37	-57	-94	36	-64	-100	Recv tuned to 110.0 MHz
7.5.2.4	10	90	100	0	0	0	37	-57	-93	36	-63	-100	Recv 323 Brg from
7.5.2.5	10	120	100	0	0	0	37	-56	-93	38	-61	-100	
7.5.2.6	10	150	100	0	0	0	34	-58	-92	38	-63	-100	
7.5.2.7	10	180	100	0	0	0	39	-57	-96	36	-63	-100	
Avg							37.4	-56.6	-93.7	37.6	-62.0	-71.4	
Median							37.0	-57.0	-94.0	38.0	-63.0	-100.0	
Std Dev							1.9	1.0	1.3	1.6	1.6	75.6	
Mode							37.0	-57.0	-94.0	36.0	-63.0	-100.0	

ECT Phase 2 – Vol. 2 – Appendices

7.5.3.1	19.5	0	100	0	0	0	38	-56	-94	37	-62	-100	BS on
7.5.3.2	19.5	30	100	0	0	0	40	-56	-95	37	-62	-100	Rcvr 6 inches
7.5.3.3	19.5	60	100	0	0	0	38	-57	-94	35	-65	-100	Rcvr tuned to 110.0 MHz
7.5.3.4	19.5	90	100	0	0	0	38	-57	-95	34	-65	-100	No brg reception
7.5.3.5	19.5	120	100	0	0	0	36	-58	-94	36	-63	-100	
7.5.3.6	19.5	150	100	0	0	0	36	-56	-91	36	-63	-100	
7.5.3.7	19.5	180	100	0	0	0	35	-61	-94	39	-60	-100	
Avg							37.3	-57.3	-93.9	36.3	-62.9	-100.0	
Median							38.0	-57.0	-94.0	36.0	-63.0	-100.0	
Std Dev							1.7	1.8	1.3	1.6	1.8	0.0	
Mode							38.0	-56.0	-94.0	37.0	-62.0	-100.0	
7.5.4.1	19.5		Rcvr 6 inches from laptop				BaseStation on			Laptop on			No brg reception
7.5.4.2	19.5		Rcvr 6 inches from laptop				BaseStation off			Laptop on			No brg reception
7.5.4.3	19.5		Rcvr 6 inches from laptop				BaseStation on			Laptop standby			Rcvr 323 Brg from
7.5.4.4	19.5		Rcvr 6 inches from laptop				BaseStation off			Laptop standby			Rcvr 323 Brg from
Summary													
							Laptop			Base station			Comments
Run	X	Time	LT	BS			SNR	Signal	Noise	SNR	Signal	Noise	
	Ft	Sec	BL	BL				dB	dB		dB	dB	
7.5.1	0		39.1	38.9									
7.5.2	10		39.1	38.9			37.4	-56.6	-93.7	37.6	-62.0	-71.4	
7.5.3	19.5		39.1	38.9			37.3	-57.3	-93.9	36.3	-62.9	-100.0	
7.5.8	20		39.1	38.9									

T-7.5: WiFi SNR Adjacent To Aircraft Nav Radio Tuned To 110.0 MHz (Mlb VOR)



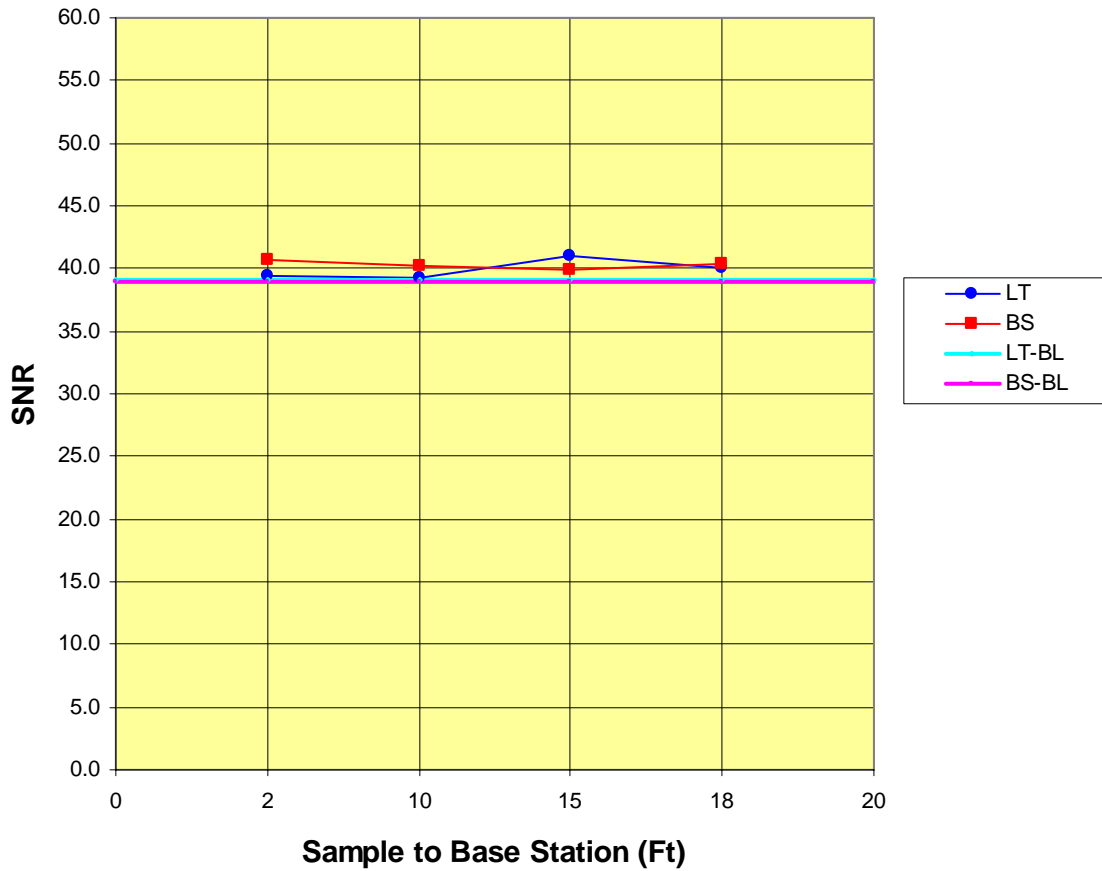
7.6

TEST 7.6: WI-FI PERFORMANCE WITH AIRCRAFT COMM RADIO

WiFi Performance Adjacent To Aircraft Com Radio													
Test	7.6												
Date	7/10/03			Time	2130								
Location			Melbourne: Wickham & Lk Washington										
Test Coordinator:			W. Harris										
Test Personnel:			None										
Hardware:			Laptop #BH				Base station:		EDL-lab1				
Address:			00-02-2D-6E-A2-F4				00-50-F2-C7-21-6C						
Encryption (WEP):			128 bit					Firewall:		on	Pings:	Open	
Test Equipment:			Laptop built-in measuring software										
Antenna:			Rear-12:00 (Vertical)										
Distance:			20 ft Basestation to laptop for most runs										
Object			VHF aircraft transceiver operated in Com receiving mode										
			Tuned to Melbourne ATIS (132.55)										
			Transmission				Laptop			Base station			Comments
Run	X	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	
	Ft	Sec	11	5.5	2	1		dB	dB		dB	dB	
7.6.1.1	NA	0	100	0	0	0	39	-55	-95	38	-61	-100	Baseline
7.6.1.2		30	100	0	0	0	39	-55	-94	38	-61	-100	VHF off
7.6.1.3		60	100	0	0	0	39	-54	-93	40	-60	-100	
7.6.1.4		90	100	0	0	0	40	-55	-94	38	-61	-100	
7.6.1.5		120	100	0	0	0	39	-55	-93	40	-60	-100	
7.6.1.6		150	100	0	0	0	37	-55	-91	39	-60	-100	
7.6.1.7		180	100	0	0	0	41	-55	-95	39	-60	-100	
Avg							39.1	-54.9	-93.6	38.9	-60.4	-100.0	
Median							39.0	-55.0	-94.0	39.0	-60.0	-100.0	
Std Dev							1.2	0.4	1.4	0.9	0.5	0.0	
Mode							39.0	-55.0	-95.0	38.0	-60.0	-100.0	
7.6.2.1	2	0	100	0	0	0	40	-54	-94	41	-58	-100	BS on
7.6.2.2	2	30	100	0	0	0	38	-54	-92	41	-59	-100	Rcvr listening
7.6.2.3	2	60	100	0	0	0	41	-54	-95	41	-60	-100	on 132.55 MHz
7.6.2.4	2	90	100	0	0	0	39	-54	-93	40	-60	-100	Audio has high noise
7.6.2.5	2	120	100	0	0	0	37	-54	-92	41	-60	-101	
7.6.2.6	2	150	100	0	0	0	41	-55	-95	40	-60	-100	
7.6.2.7	2	180	100	0	0	0	40	-54	-94	41	-60	-100	
Avg							39.4	-54.1	-93.6	40.7	-59.6	-100.1	
Median							40.0	-54.0	-94.0	41.0	-60.0	-100.0	
Std Dev							1.5	0.4	1.3	0.5	0.8	0.4	
Mode							40.0	-54.0	-94.0	41.0	-60.0	-100.0	
7.6.3.1	10	0	100	0	0	0	40	-55	-95	40	-59	100	BS on
7.6.3.2	10	30	100	0	0	0	39	-54	-95	40	-59	100	Rcvr listening
7.6.3.3	10	60	100	0	0	0	38	-54	-93	40	-59	100	on 132.55 MHz
7.6.3.4	10	90	100	0	0	0	38	-54	-93	40	-59	100	Audio has best reception
7.6.3.5	10	120	100	0	0	0	39	-54	-93	41	-58	100	
7.6.3.6	10	150	100	0	0	0	41	-55	-96	40	-60	100	
7.6.3.7	10	180	100	0	0	0	40	-54	-94	40	-60	100	
Avg							39.3	-54.3	-94.1	40.1	-59.1	100.0	
Median							39.0	-54.0	-94.0	40.0	-59.0	100.0	
Std Dev							1.1	0.5	1.2	0.4	0.7	0.0	
Mode							40.0	-54.0	-93.0	40.0	-59.0	100.0	

7.6.4.1	15	0	100	0	0	0	44	-54	-99	41	-59	-100	BS on
7.6.4.2	15	30	100	0	0	0	42	-55	-97	40	-59	-100	Rcvr listening
7.6.4.3	15	60	100	0	0	0	41	-55	-97	41	-59	-100	on 132.55 MHz
7.6.4.4	15	90	100	0	0	0	38	-55	-93	40	-60	-101	Audio all static, no voice
7.6.4.5	15	120	100	0	0	0	41	-55	-96	40	-60	-100	
7.6.4.6	15	150	100	0	0	0	41	-56	-97	37	-62	-100	
7.6.4.7	15	180	100	0	0	0	40	-56	-95	40	-60	-100	
Avg							41.0	-55.1	-96.3	39.9	-59.9	-100.1	
Median							41.0	-55.0	-97.0	40.0	-60.0	-100.0	
Std Dev							1.8	0.7	1.9	1.3	1.1	0.4	
Mode							41.0	-55.0	-97.0	40.0	-59.0	-100.0	
7.6.5.1	18	0	100	0	0	0	43	-54	-97	41	-60	-100	BS on
7.6.5.2	18	30	100	0	0	0	41	-55	-95	40	-60	-100	Rcvr listening
7.6.5.3	18	60	100	0	0	0	39	-54	-95	40	-60	-100	on 132.55 MHz
7.6.5.4	18	90	100	0	0	0	38	-55	-93	40	-60	-101	Audio all static, no voice
7.6.5.5	18	120	100	0	0	0	37	-54	-92	41	-60	-100	
7.6.5.6	18	150	100	0	0	0	41	-54	-95	41	-59	-100	
7.6.5.7	18	180	100	0	0	0	41	-54	-97	40	-60	-100	
Avg							40.0	-54.3	-94.9	40.4	-59.9	-100.1	
Median							41.0	-54.0	-95.0	40.0	-60.0	-100.0	
Std Dev							2.1	0.5	1.9	0.5	0.4	0.4	
Mode							41.0	-54.0	-95.0	40.0	-60.0	-100.0	
Summary													
							Laptop			Base station			Comments
Run	X	Time	LT	BS			SNR	Signal	Noise	SNR	Signal	Noise	
	Ft	Sec	BL	BL				dB	dB		dB	dB	
7.6.1	0		39.1	38.9									
7.6.2	2		39.1	38.9			39.4	-54.1	-93.6	40.7	-59.6	-100.1	
7.6.3	10		39.1	38.9			39.3	-54.3	-94.1	40.1	-59.1	100.0	
7.6.4	15		39.1	38.9			41.0	-55.1	-96.3	39.9	-59.9	-100.1	
7.6.5	18		39.1	38.9			40.0	-54.3	-94.9	40.4	-59.9	-100.1	
7.6.6	20		39.1	38.9									
7.6.7	2						BaseStation off			Laptop on			Lite voice
7.6.8	19.5						BaseStation off			Laptop on			Best voice
7.6.9	19.5						BaseStation off			Laptop on			No voice
7.6.10	19.5						BaseStation off			Laptop on			No voice

T-7.6: WiFi SNR Adjacent To Aircraft Com Radio Tuned To 132.55 MHz (Mlb ATIS)



7.7

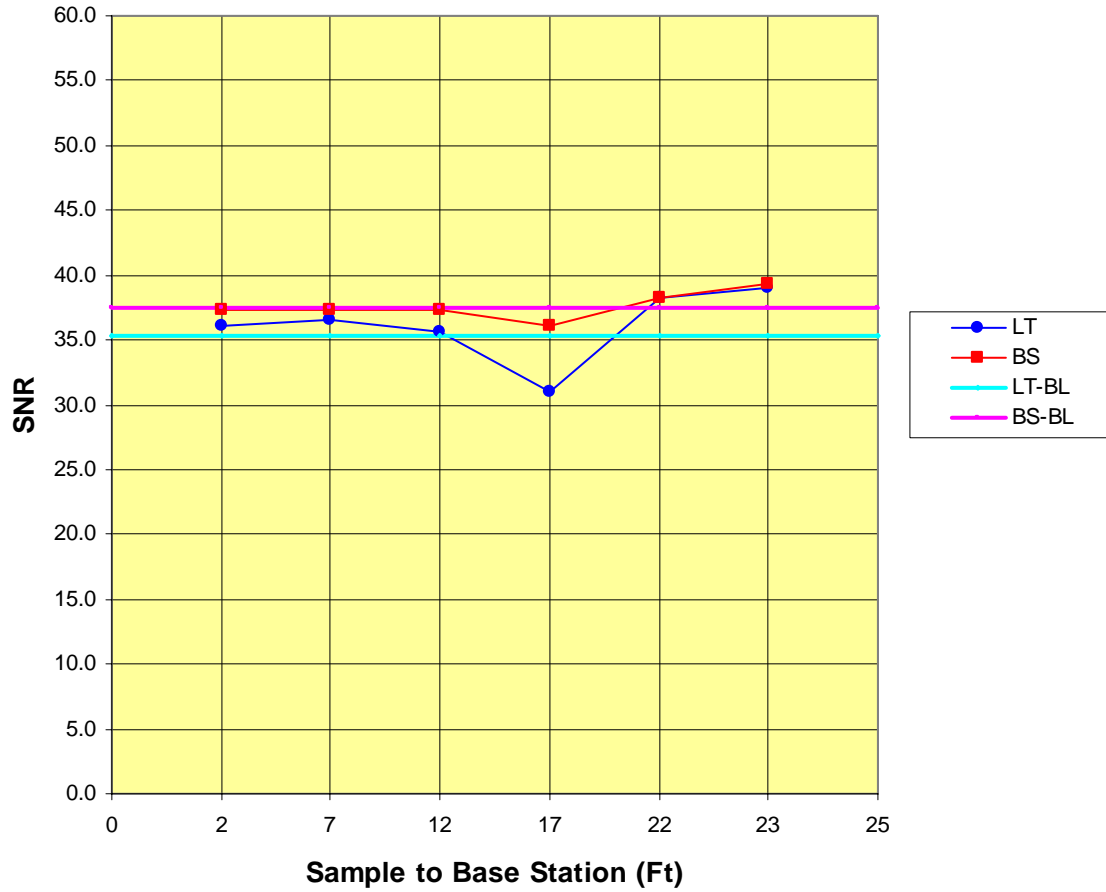
TEST 7.7: WI-FI PERFORMANCE WITH GPS RECEIVER

WiFi Performance Adjacent To GPS Receiver													
Test	7.7												
Date	7/14/03			Time	9 PM								
Location				Melbourne: Wickham & Lk Washington									
Test Coordinator:				W. Harris									
Test Personnel:													
Hardware:				Laptop	#BH		Base station:	EDL-lab 1					
Address:				00-02-2D-6E-A2-F4					00-50-F2-C7-21-6C				
Encryption (WEP):				128 bit			Firewall:	on	Pings:	Open			
Test Equipment:				Laptop built-in measuring software					Cal:	new			
Antenna:				Rear-12:00 (Vertical)									
Distance:				25 ft Base Station to laptop									
Object				Lorance Air Map 5 channel GPS									
			Transmission				Laptop			Base station			Comments
Run	X	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	
	Ft	Sec	11	5.5	2	1		dB	dB		dB	dB	
7.7.1.1	NA	0	100	0	0	0	33	-59	-93	38	-61	-99	Baseline
7.7.1.2		30	100	0	0	0	34	-58	-93	37	-61	-100	GPS off
7.7.1.3		60	100	0	0	0	37	-58	-95	37	-61	-100	
7.7.1.4		90	100	0	0	0	33	-58	-97	38	-61	-100	
7.7.1.5		120	100	0	0	0	36	-59	-95	37	-61	-100	
7.7.1.6		150	100	0	0	0	39	-58	-97	37	-62	-100	
7.7.1.7		180	100	0	0	0	35	-59	-94	38	-61	-100	
Avg							35.3	-58.4	-94.9	37.4	-61.1	-99.9	
Median							35.0	-58.0	-95.0	37.0	-61.0	-100.0	
Std Dev							2.2	0.5	1.7	0.5	0.4	0.4	
Mode							33.0	-58.0	-93.0	37.0	-61.0	-100.0	
7.7.2.1	2	0	100	0	0	0	36	-60	-96	36	-61	-100	Location:
7.7.2.2	2	30	100	0	0	0	34	-57	-91	37	-60	-100	N28-09.172
7.7.2.3	2	60	100	0	0	0	34	-56	-90	37	-61	-100	W80-40.725
7.7.2.4	2	90	100	0	0	0	38	-57	-95	38	-60	-100	
7.7.2.5	2	120	100	0	0	0	38	-57	-95	38	-60	-100	
7.7.2.6	2	150	100	0	0	0	35	-58	-94	37	-61	-100	
7.7.2.7	2	180	100	0	0	0	38	-56	-94	38	-60	-100	
Avg							36.1	-57.3	-93.6	37.3	-60.4	-100.0	
Median							36.0	-57.0	-94.0	37.0	-60.0	-100.0	
Std Dev							1.9	1.4	2.2	0.8	0.5	0.0	
Mode							38.0	-57.0	-95.0	37.0	-60.0	-100.0	
7.7.3.1	7	0	100	0	0	0	39	-56	-94	37	-61	-100	Location:
7.7.3.2	7	30	100	0	0	0	35	-57	-93	36	-61	-100	N28-09.172
7.7.3.3	7	60	100	0	0	0	37	-57	-93	36	-62	-100	W80-40.726
7.7.3.4	7	90	100	0	0	0	35	-57	-92	38	-61	-100	
7.7.3.5	7	120	100	0	0	0	39	-55	-95	37	-61	-100	
7.7.3.6	7	150	100	0	0	0	35	-55	-91	39	-60	-100	
7.7.3.7	7	180	100	0	0	0	36	-56	-91	38	-60	-100	
Avg							36.6	-56.1	-92.7	37.3	-60.9	-100.0	
Median							36.0	-56.0	-93.0	37.0	-61.0	-100.0	
Std Dev							1.8	0.9	1.5	1.1	0.7	0.0	
Mode							35.0	-57.0	-93.0	37.0	-61.0	-100.0	

ECT Phase 2 – Vol. 2 – Appendices

7.7.4.1	12	0	100	0	0	0	35	-56	-93	39	-61	-100	Location:
7.7.4.2	12	30	100	0	0	0	34	-59	-92	36	-63	-100	N28-09.176
7.7.4.3	12	60	100	0	0	0	36	-58	-92	36	-62	-100	W 80-40.727
7.7.4.4	12	90	100	0	0	0	36	-57	-93	38	-62	-100	
7.7.4.5	12	120	100	0	0	0	37	-58	-95	37	-62	-100	
7.7.4.6	12	150	100	0	0	0	34	-58	-91	38	-62	-100	
7.7.4.7	12	180	100	0	0	0	37	-56	-93	37	-62	-100	
Avg							35.6	-57.4	-92.7	37.3	-62.0	-100.0	
Median							36.0	-58.0	-93.0	37.0	-62.0	-100.0	
Std Dev							1.3	1.1	1.3	1.1	0.6	0.0	
Mode							34.0	-58.0	-93.0	36.0	-62.0	-100.0	
7.7.5.1	17	0	100	0	0	0	31	-61	-91	36	-63	-100	Location:
7.7.5.2	17	30	100	0	0	0	33	-60	-95	36	-62	-100	N28-09.172
7.7.5.3	17	60	100	0	0	0	31	-61	-92	37	-62	-100	W 80-40.726
7.7.5.4	17	90	100	0	0	0	27	-63	-91	35	-63	-100	
7.7.5.5	17	120	100	0	0	0	35	-60	-95	36	-63	-100	
7.7.5.6	17	150	100	0	0	0	30	-61	-93	36	-63	-100	
7.7.5.7	17	180	100	0	0	0	30	-61	-91	37	-62	-100	
Avg							31.0	-61.0	-92.6	36.1	-62.6	-100.0	
Median							31.0	-61.0	-92.0	36.0	-63.0	-100.0	
Std Dev							2.5	1.0	1.8	0.7	0.5	0.0	
Mode							31.0	-61.0	-91.0	36.0	-63.0	-100.0	
7.7.6.1	22	0	100	0	0	0	39	-54	-94	39	-60	-100	Location:
7.7.6.2	22	30	100	0	0	0	37	-55	-92	38	-61	-99	N28-09.173
7.7.6.3	22	60	100	0	0	0	40	-55	-95	38	-60	-99	W 80-40.727
7.7.6.4	22	90	100	0	0	0	38	-55	-93	39	-60	-100	
7.7.6.5	22	120	100	0	0	0	37	-54	-91	38	-60	-100	
7.7.6.6	22	150	100	0	0	0	38	-55	-92	38	-59	-100	
7.7.6.7	22	180	100	0	0	0	39	-55	-93	38	-61	-100	
Avg							38.3	-54.7	-92.9	38.3	-60.1	-99.7	
Median							38.0	-55.0	-93.0	38.0	-60.0	-100.0	
Std Dev							1.1	0.5	1.3	0.5	0.7	0.5	
Mode							39.0	-55.0	-92.0	38.0	-60.0	-100.0	
7.7.7.1	23	0	100	0	0	0	38	-55	-93	38	-59	-100	Location:
7.7.7.2	23	30	100	0	0	0	39	-54	-93	39	-59	-100	N28-09.173
7.7.7.3	23	60	100	0	0	0	38	-55	-92	39	-60	-100	W 80-40.730
7.7.7.4	23	90	100	0	0	0	39	-54	-93	40	-60	-100	
7.7.7.5	23	120	100	0	0	0	39	-55	-93	38	-60	-100	
7.7.7.6	23	150	100	0	0	0	38	-54	-91	40	-59	-100	
7.7.7.7	23	180	100	0	0	0	41	-54	-95	40	-59	-100	
Avg							39.0	-54.3	-92.8	39.3	-59.5	-100.0	
Median							38.5	-54.5	-93.0	39.0	-59.5	-100.0	
Std Dev							0.5	0.5	0.8	0.9	0.5	0.0	
Mode							38.0	-55.0	-93.0	38.0	-59.0	-100.0	

Summary													
Run	X	Time	LT	BS			Laptop			Base station			Comments
	Ft	Sec	BL	BL			SNR	Signal dB	Noise dB	SNR	Signal dB	Noise dB	
7.7.1	0		35.3	37.4									
7.7.2	2		35.3	37.4			36.1	-57.3	-93.6	37.3	-60.4	-100.0	
7.7.3	7		35.3	37.4			36.6	-56.1	-92.7	37.3	-60.9	-100.0	
7.7.4	12		35.3	37.4			35.6	-57.4	-92.7	37.3	-62.0	-100.0	
7.7.5	17		35.3	37.4			31.0	-61.0	-92.6	36.1	-62.6	-100.0	
7.7.6	22		35.3	37.4			38.3	-54.7	-92.9	38.3	-60.1	-99.7	
7.7.7	23		35.3	37.4			39.0	-54.3	-92.8	39.3	-59.5	-100.0	
7.7.8	25		35.3	37.4									

T-7.7: WiFi SNR Adjacent To GPS Receiver

7.8

TEST 7.8: WI-FI PERFORMANCE WITH IRIDIUM PHONE

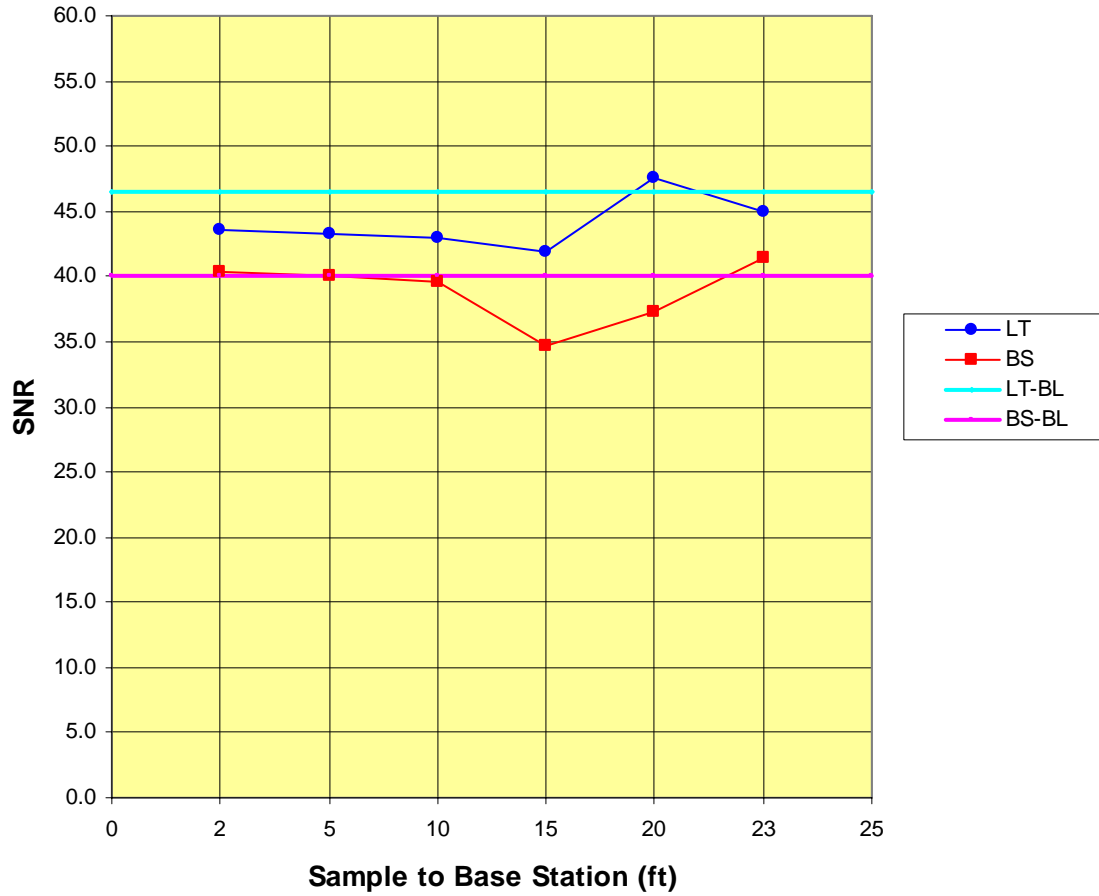
WiFi Performance Adjacent To Iridium Phone													
Test	7.8												
Date	4/15/03			Time	830								
Location			EDL Advanced Network Development Lab										
Test Coordinator:			W. Harris										
Test Personnel:			Bill Haskell										
Hardware:			Laptop #BH				Base station:		EDL-lab 1				
Address:			00-02-2D-6E-A2-F4				00-50-F2-C7-21-6C						
Encryption (WEP):			128 bit				Firewall:		on	Pings:	Open		
Test Equipment:			Laptop built-in measuring software							Cal:	new		
Antenna:			Rear-12:00 (Vertical)										
Distance:			25 ft										
Object			Iridium Phone placed at distances shown.										
			Transmission				Laptop			Base station			Comments
Run	X	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	
	Ft	Sec	11	5.5	2	1		dB	dB		dB	dB	
7.8.1.1	NA	0	100	0	0	0	50	-48	-98	41	-56	-96	Baseline
7.8.1.2		30	100	0	0	0	46	-48	-93	40	-57	-96	No Xmtr
7.8.1.3		60	100	0	0	0	47	-47	-95	39	-58	-96	
7.8.1.4		90	100	0	0	0	46	-47	-92	40	-56	-94	
7.8.1.5		120	100	0	0	0	47	-47	-94	42	-56	-96	
7.8.1.6		150	100	0	0	0	45	-47	-93	39	-56	-95	
7.8.1.7		180	100	0	0	0	44	-47	-92	39	-57	-95	
Avg							46.4	-47.3	-93.9	40.0	-56.6	-95.4	
Median							46.0	-47.0	-93.0	40.0	-56.0	-96.0	
Std Dev							1.9	0.5	2.1	1.2	0.8	0.8	
Mode							46.0	-47.0	-93.0	39.0	-56.0	-96.0	
7.8.2.1	2	0	100	0	0	0	43	-48	-91	42	-56	-98	Phone Xmtr on
7.8.2.2	2	30	100	0	0	0	44	-50	-95	40	-57	-98	
7.8.2.3	2	60	100	0	0	0	42	-50	-93	40	-57	-98	
7.8.2.4	2	90	100	0	0	0	42	-51	-94	41	-56	-98	
7.8.2.5	2	120	100	0	0	0	42	-51	-93	41	-56	-98	
7.8.2.6	2	150	100	0	0	0	45	-50	-94	41	-56	-97	
7.8.2.7	2	180	100	0	0	0	47	-51	-97	38	-59	-98	
Avg							43.6	-50.1	-93.9	40.4	-56.7	-97.9	
Median							43.0	-50.0	-94.0	41.0	-56.0	-98.0	
Std Dev							1.9	1.1	1.9	1.3	1.1	0.4	
Mode							42.0	-50.0	-93.0	41.0	-56.0	-98.0	
7.8.3.1	5	0	100	0	0	0	43	-49	-94	42	-57	-98	UWB Xmtr on
7.8.3.2	5	30	100	0	0	0	42	-50	-94	41	-57	-97	
7.8.3.3	5	60	100	0	0	0	46	-51	-96	40	-57	-95	
7.8.3.4	5	90	100	0	0	0	42	-51	-93	39	-58	-97	
7.8.3.5	5	120	100	0	0	0	42	-51	-95	38	-59	-98	
7.8.3.6	5	150	100	0	0	0	41	-52	-92	39	-58	-98	
7.8.3.7	5	180	100	0	0	0	47	-51	-98	41	-58	-98	
Avg							43.3	-50.7	-94.6	40.0	-57.7	-97.3	
Median							42.0	-51.0	-94.0	40.0	-58.0	-98.0	
Std Dev							2.3	1.0	2.0	1.4	0.8	1.1	
Mode							42.0	-51.0	-94.0	41.0	-57.0	-98.0	

ECT Phase 2 – Vol. 2 – Appendices

7.8.4.1	10	0	100	0	0	0	45	-50	-95	39	-58	-97	UWB Xmtr on
7.8.4.2	10	30	100	0	0	0	46	-52	-98	40	-57	-98	
7.8.4.3	10	60	100	0	0	0	42	-53	-95	39	-58	-98	
7.8.4.4	10	90	100	0	0	0	39	-52	-92	39	-58	-98	
7.8.4.5	10	120	100	0	0	0	40	-51	-92	40	-58	-98	
7.8.4.6	10	150	100	0	0	0	43	-51	-94	40	-58	-98	
7.8.4.7	10	180	100	0	0	0	46	-50	-96	40	-57	-98	
Avg							43.0	-51.3	-94.6	39.6	-57.7	-97.9	
Median							43.0	-51.0	-95.0	40.0	-58.0	-98.0	
Std Dev							2.8	1.1	2.1	0.5	0.5	0.4	
Mode							46.0	-50.0	-95.0	40.0	-58.0	-98.0	
7.8.5.1	15	0	100	0	0	0	41	-53	-94	35	-62	-98	UWB Xmtr on
7.8.5.2	15	30	100	0	0	0	39	-53	-95	35	-62	-97	
7.8.5.3	15	60	100	0	0	0	37	-55	-92	34	-63	-98	
7.8.5.4	15	90	100	0	0	0	43	-51	-95	34	-62	-95	
7.8.5.5	15	120	100	0	0	0	46	-50	-95	36	-61	-97	
7.8.5.6	15	150	100	0	0	0	44	-50	-94	34	-63	-96	
7.8.5.7	15	180	100	0	0	0	43	-51	-94	35	-62	-98	
Avg							41.9	-51.9	-94.1	34.7	-62.1	-97.0	
Median							43.0	-51.0	-94.0	35.0	-62.0	-97.0	
Std Dev							3.1	1.9	1.1	0.8	0.7	1.2	
Mode							43.0	-53.0	-94.0	35.0	-62.0	-98.0	
7.8.6.1	20	0	100	0	0	0	49	-46	-95	36	-61	-98	UWB Xmtr on
7.8.6.2	20	30	100	0	0	0	49	-47	-95	38	-59	-98	
7.8.6.3	20	60	100	0	0	0	47	-46	-93	39	-59	-98	
7.8.6.4	20	90	100	0	0	0	47	-48	-95	37	-60	-98	
7.8.6.5	20	120	100	0	0	0	48	-48	-96	38	-59	-98	
7.8.6.6	20	150	100	0	0	0	47	-48	-95	36	-61	-98	
7.8.6.7	20	180	100	0	0	0	46	-48	-95	37	-60	-98	
Avg							47.6	-47.3	-94.9	37.3	-59.9	-98.0	
Median							47.0	-48.0	-95.0	37.0	-60.0	-98.0	
Std Dev							1.1	1.0	0.9	1.1	0.9	0.0	
Mode							47.0	-48.0	-95.0	36.0	-59.0	-98.0	
7.8.7.1	23	0	100	0	0	0	43	-51	-93	40	-57	-98	
7.8.7.2	23	30	100	0	0	0	45	-50	-95	40	-58	-98	
7.8.7.3	23	60	100	0	0	0	46	-50	-96	41	-56	-98	
7.8.7.4	23	90	100	0	0	0	45	-51	-97	42	-56	-98	
7.8.7.5	23	120	100	0	0	0	42	-51	-93	42	-56	-98	
7.8.7.6	23	150	100	0	0	0	48	-52	-99	42	-55	-98	
7.8.7.7	23	180	100	0	0	0	44	-52	-95	42	-55	-98	
Avg							45.0	-51.0	-95.8	41.5	-56.0	-98.0	
Median							45.0	-51.0	-95.5	41.5	-56.0	-98.0	
Std Dev							2.1	0.8	2.3	1.0	1.0	0.0	
Mode							45.0	-51.0	-93.0	42.0	-56.0	-98.0	

Summary													
Run	X	Time	LT	BS			Laptop			Base station			Comments
	Ft	Sec	BL	BL			SNR	Signal	Noise	SNR	Signal	Noise	
								dB	dB		dB	dB	
7.8.1	0		46.4	40.0									
7.8.2	2		46.4	40.0			43.6	-50.1	-93.9	40.4	-56.7	-97.9	
7.8.3	5		46.4	40.0			43.3	-50.7	-94.6	40.0	-57.7	-97.3	
7.8.4	10		46.4	40.0			43.0	-51.3	-94.6	39.6	-57.7	-97.9	
7.8.5	15		46.4	40.0			41.9	-51.9	-94.1	34.7	-62.1	-97.0	
7.8.6	20		46.4	40.0			47.6	-47.3	-94.9	37.3	-59.9	-98.0	
7.8.7	23		46.4	40.0			45.0	-51.0	-95.8	41.5	-56.0	-98.0	
7.8.8	25		46.4	40.0									

T-7.8: WiFi SNR Adjacent To Iridium Phone



8.0

TEST 8: WI-FI PERF COMPARISON OF 802.11B AND 802.11G

WiFi Performance With 802.11b And 802.11g																
Test	8															
Date	8/28/03					Time	0415									
Location						EDL first floor hall										
Test Coordinator:						W. Harris										
Test Personnel:																
Hardware:						EDL-lab1 with #GB		EDL-lab3 with #BH								
Address:						00-02-2D-6E-A2-04-50-F2-C7-C5-6C										
Encryption (WEP):						128 bit		Firewall:		on	Pings:	Open				
Test Equipment:						Laptop built-in measuring software					Cal:	new				
Antenna:						Rear-12:00 (Vertical)										
Distance:						Variable										
			BS & Laptop				Laptop			Base station			Access Point			Comments
Run	Dist	Time	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	Speed (Mbps)			
			11	5.5	2	1		dB	dB		dB	dB	Mbps	Qual	Strength	
5.2.1.1	10	0	100	0	0	0	46	-46	-92	45	-54	-100	54	100	100	
5.2.1.2	10	30	100	0	0	0	44	-45	-90	46	-52	-100	54	100	100	
5.2.1.3	10	60	100	0	0	0	47	-44	-92	47	-52	-100	54	100	100	
5.2.1.4	10	90	100	0	0	0	49	-44	-92	48	-52	-100	54	100	100	
5.2.1.5	10	120	100	0	0	0	49	-44	-92	48	-51	-100	54	100	100	
5.2.1.6	10	150	100	0	0	0	48	-44	-92	47	-52	-100	54	100	100	
5.2.1.7	10	180	100	0	0	0	49	-44	-92	47	-52	-100	54	100	100	
Avg			100.0	0.0	0.0	0	47.4	-44.4	-91.7	46.9	-52.1	-100.0	54.0	100.0	100.0	
Median			100.0	0.0	0.0	0	48.0	-44.0	-92.0	47.0	-52.0	-100.0	54.0	100.0	100.0	
Std Dev			0.0	0.0	0.0	0	1.9	0.8	0.8	1.1	0.9	0.0	0.0	0.0	0.0	
Mode			100.0	0.0	0.0	0	49.0	-44.0	-92.0	47.0	-52.0	-100.0	54.0	100.0	100.0	
5.2.2.1	20	0	100	0	0	0	42	-49	-90	44	-54	-100	54	100	100	
5.2.2.2	20	30	100	0	0	0	42	-49	-90	44	-54	-100	54	100	100	
5.2.2.3	20	60	100	0	0	0	42	-49	-90	44	-54	-100	54	83	100	
5.2.2.4	20	90	100	0	0	0	42	-49	-90	44	-54	-100	54	100	100	
5.2.2.5	20	120	100	0	0	0	42	-49	-90	44	-54	-100	54	100	100	
5.2.2.6	20	150	100	0	0	0	42	-49	-90	44	-54	-100	54	100	100	
5.2.2.7	20	180	100	0	0	0	42	-49	-90	44	-54	-100	54	100	100	
Avg			100.0	0.0	0.0	0	42.0	-49.0	-90.0	44.0	-54.0	-100.0	54.0	97.6	100.0	
Median			100.0	0.0	0.0	0	42.0	-49.0	-90.0	44.0	-54.0	-100.0	54.0	100.0	100.0	
Std Dev			0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	6.4	0.0	
Mode			100.0	0.0	0.0	0	42.0	-49.0	-90.0	44.0	-54.0	-100.0	54.0	100.0	100.0	
5.2.3.1	30	0	100	0	0	0	42	-50	-93	38	-61	-100	48	100	100	
5.2.3.2	30	30	100	0	0	0	43	-50	-91	37	-62	-100	48	100	100	
5.2.3.3	30	60	100	0	0	0	43	-50	-92	39	-59	-100	48	91	100	
5.2.3.4	30	90	100	0	0	0	40	-51	-91	36	-62	-100	36	95	96	
5.2.3.5	30	120	100	0	0	0	38	-51	-91	35	-63	-100	36	93	91	
5.2.3.6	30	150	100	0	0	0	38	-51	-90	36	-63	-100	36	90	100	
5.2.3.7	30	180	100	0	0	0	41	-52	-92	38	-60	-100	36	100	100	
Avg			100.0	0.0	0.0	0	40.7	-50.7	-91.4	37.0	-61.4	-100.0	41.1	95.6	98.1	
Median			100.0	0.0	0.0	0	41.0	-51.0	-91.0	37.0	-62.0	-100.0	36.0	95.0	100.0	
Std Dev			0.0	0.0	0.0	0	2.1	0.8	1.0	1.4	1.5	0.0	6.4	4.4	3.5	
Mode			100.0	0.0	0.0	0	43.0	-50.0	-91.0	38.0	-62.0	-100.0	36.0	100.0	100.0	

ECT Phase 2 – Vol. 2 – Appendices

5.2.4.1	40	0	100	0	0	0	38	-54	-91	34	-64	-100	54	80	100	Web cmd
5.2.4.2	40	30	100	0	0	0	40	-53	-92	34	-64	-100	54	79	100	
5.2.4.3	40	60	100	0	0	0	38	-53	-90	34	-65	-100	54	100	100	
5.2.4.4	40	90	100	0	0	0	37	-53	-91	35	-64	-100	54	100	100	
5.2.4.5	40	120	100	0	0	0	37	-54	-91	35	-63	-100	54	100	100	
5.2.4.6	40	150	100	0	0	0	39	-55	-93	37	-62	-100	54	100	100	
5.2.4.7	40	180	100	0	0	0	38	-55	-92	33	-64	-100	54	100	100	
Avg			100.0	0.0	0.0	0	38.1	-53.9	-91.4	34.6	-63.7	-100.0	54.0	94.1	100.0	
Median			100.0	0.0	0.0	0	38.0	-54.0	-91.0	34.0	-64.0	-100.0	54.0	100.0	100.0	
Std Dev			0.0	0.0	0.0	0	1.1	0.9	1.0	1.3	1.0	0.0	0.0	10.0	0.0	
Mode			100.0	0.0	0.0	0	38.0	-53.0	-91.0	34.0	-64.0	-100.0	54.0	100.0	100.0	
5.2.5.1	50	0	100	0	0	0	37	-56	-93	34	-64	-100	54	100	100	Web cmd
5.2.5.2	50	30	100	0	0	0	36	-57	-92	34	-64	-100	54	100	100	
5.2.5.3	50	60	100	0	0	0	35	-56	-92	34	-65	-100	54	100	100	
5.2.5.4	50	90	100	0	0	0	34	-58	-92	34	-64	-100	54	100	100	
5.2.5.5	50	120	100	0	0	0	35	-59	-93	33	-64	-100	48	100	100	
5.2.5.6	50	150	100	0	0	0	34	-58	-92	33	-64	-100	48	100	85	
5.2.5.7	50	180	100	0	0	0	32	-58	-90	32	-66	-100	24	100	8	
Avg			100.0	0.0	0.0	0	34.7	-57.4	-92.0	33.4	-64.4	-100.0	48.0	100.0	84.7	
Median			100.0	0.0	0.0	0	35.0	-58.0	-92.0	34.0	-64.0	-100.0	54.0	100.0	100.0	
Std Dev			0.0	0.0	0.0	0	1.6	1.1	1.0	0.8	0.8	0.0	11.0	0.0	34.3	
Mode			100.0	0.0	0.0	0	35.0	-58.0	-92.0	34.0	-64.0	-100.0	54.0	100.0	100.0	
5.2.6.1	60	0	100	0	0	0	36	-57	-92	36	-61	-100	54	100	100	Web cmd
5.2.6.2	60	30	100	0	0	0	34	-55	-89	36	-63	-100	54	100	100	
5.2.6.3	60	60	100	0	0	0	38	-55	-92	37	-62	-100	54	84	100	
5.2.6.4	60	90	100	0	0	0	36	-56	-92	37	-62	-100	54	100	100	
5.2.6.5	60	120	100	0	0	0	36	-55	-92	35	-64	-100	54	100	100	
5.2.6.6	60	150	100	0	0	0	37	-56	-93	36	-63	-100	54	100	100	
5.2.6.7	60	180	100	0	0	0	37	-56	-92	36	-63	-100	54	100	100	
Avg			100.0	0.0	0.0	0	36.3	-55.7	-91.7	36.1	-62.6	-100.0	54.0	97.7	100.0	
Median			100.0	0.0	0.0	0	36.0	-56.0	-92.0	36.0	-63.0	-100.0	54.0	100.0	100.0	
Std Dev			0.0	0.0	0.0	0	1.3	0.8	1.3	0.7	1.0	0.0	0.0	6.0	0.0	
Mode			100.0	0.0	0.0	0	36.0	-55.0	-92.0	36.0	-63.0	-100.0	54.0	100.0	100.0	
5.2.7.1	70	0	99	0	0	0	22	-71	-93	24	-74	-100	54	100	100	Web cmd
5.2.7.2	70	30	99	0	0	0	24	-67	-90	31	-67	-100	48	100	100	
5.2.7.3	70	60	99	0	0	0	24	-66	-91	30	-69	-100	48	100	100	
5.2.7.4	70	90	98	1	0	0	28	-65	-92	31	-68	-100	48	100	100	
5.2.7.5	70	120	98	1	0	0	24	-68	-92	28	-70	-100	48	100	100	
5.2.7.6	70	150	98	1	0	0	26	-66	-92	29	-68	-100	48	100	100	
5.2.7.7	70	180	98	1	0	0	25	-67	-93	28	-70	-100	48	100	100	
Avg			98.4	0.6	0.0	0	24.7	-67.1	-91.9	28.7	-69.4	-100.0	48.9	100.0	100.0	
Median			98.0	1.0	0.0	0	24.0	-67.0	-92.0	29.0	-69.0	-100.0	48.0	100.0	100.0	
Std Dev			0.5	0.5	0.0	0	1.9	2.0	1.1	2.4	2.3	0.0	2.3	0.0	0.0	
Mode			98.0	1.0	0.0	0	24.0	-67.0	-92.0	31.0	-68.0	-100.0	48.0	100.0	100.0	
5.2.8.1	80	0	93	6	0	0	32	-62	-92	29	-68	-99	54	100	100	Web cmd
5.2.8.2	80	30	88	11	0	0	30	-61	-92	29	-70	-100	54	86	100	
5.2.8.3	80	60	89	10	0	0	31	-62	-92	31	-68	-100	54	100	100	
5.2.8.4	80	90	92	7	0	0	29	-62	-92	31	-66	-100	54	100	100	
5.2.8.5	80	120	93	6	0	0	29	-62	-91	32	-67	-100	54	100	100	
5.2.8.6	80	150	94	5	0	0	29	-61	-91	33	-66	-100	54	100	100	
5.2.8.7	80	180	95	4	0	0	30	-62	-92	33	-65	-100	54	100	100	
Avg			92.0	7.0	0.0	0	30.0	-61.7	-91.7	31.1	-67.1	-99.9	54.0	98.0	100.0	
Median			93.0	6.0	0.0	0	30.0	-62.0	-92.0	31.0	-67.0	-100.0	54.0	100.0	100.0	
Std Dev			2.6	2.6	0.0	0	1.2	0.5	0.5	1.7	1.7	0.4	0.0	5.3	0.0	
Mode			93.0	6.0	0.0	0	29.0	-62.0	-92.0	29.0	-68.0	-100.0	54.0	100.0	100.0	
5.2.9.1	90	0	100	0	0	0	30	-62	-92	29	-69	-98	54	78	100	Web cmd
5.2.9.2	90	30	89	10	0	0	29	-62	-91	28	-69	-100	54	100	100	
5.2.9.3	90	60	81	18	0	0	29	-62	-90	28	-71	-100	54	100	100	
5.2.9.4	90	90	78	19	0	0	31	-62	-93	22	-75	-100	54	100	100	
5.2.9.5	90	120	67	27	4	0	27	-64	-92	28	-70	-100	54	100	100	
5.2.9.6	90	150	62	30	6	0	26	-66	-92	24	-74	-100	54	100	100	
5.2.9.7	90	180	60	33	6	0	27	-66	-92	25	-74	-100	54	100	100	
Avg			76.7	19.6	2.3	0	28.4	-63.4	-91.7	26.3	-71.7	-99.7	54.0	96.9	100.0	
Median			78.0	19.0	0.0	0	29.0	-62.0	-92.0	28.0	-71.0	-100.0	54.0	100.0	100.0	
Std Dev			14.7	11.7	2.9	0	1.8	1.9	1.0	2.6	2.6	0.8	0.0	8.3	0.0	
Mode			#N/A	#N/A	0.0	0	29.0	-62.0	-92.0	28.0	-69.0	-100.0	54.0	100.0	100.0	

ECT Phase 2 – Vol. 2 – Appendices

5.2.10.1	100	0	100	0	0	0	34	-58	-92	32	-65	-98	54	100	100	Web cmd
5.2.10.2	100	30	100	0	0	0	36	-56	-91	33	-66	-100	54	100	100	
5.2.10.3	100	60	100	0	0	0	35	-57	-92	32	-66	-100	54	100	100	
5.2.10.4	100	90	100	0	0	0	37	-56	-93	32	-66	-100	54	84	100	
5.2.10.5	100	120	100	0	0	0	34	-56	-90	31	-67	-100	54	100	100	
5.2.10.6	100	150	100	0	0	0	36	-56	-92	32	-66	-100	54	100	100	
5.2.10.7	100	180	100	0	0	0	36	-56	-91	32	-67	-100	54	100	100	
Avg			100.0	0.0	0	0	35.4	-56.4	-91.6	32.0	-66.1	-99.7	54.0	97.7	100	
Median			100.0	0.0	0	0	36.0	-56.0	-92.0	32.0	-66.0	-100.0	54.0	100.0	100	
Std Dev			0.0	0.0	0	0	1.1	0.8	1.0	0.6	0.7	0.8	0.0	6.0	0	
Mode			100.0	0.0	0	0	36.0	-56.0	-92.0	32.0	-66.0	-100.0	54.0	100.0	100	
5.2.11.1	110	0	100	0	0	0	25	-67	-92	31	-66	-98	48	100	100	Web cmd
5.2.11.2	110	30	100	0	0	0	25	-66	-91	31	-66	-100	54	100	100	
5.2.11.3	110	60	100	0	0	0	24	-67	-92	32	-67	-100	54	100	100	
5.2.11.4	110	90	100	0	0	0	25	-66	-91	32	-67	-100	54	100	100	
5.2.11.5	110	120	100	0	0	0	27	-64	-92	26	-72	-100	54	100	100	
5.2.11.6	110	150	100	0	0	0	28	-64	-92	32	-66	-99	54	82	100	
5.2.11.7	110	180	100	0	0	0	27	-65	-92	30	-68	-100	54	100	100	
Avg			100.0	0.0	0	0	25.9	-65.6	-91.7	30.6	-67.4	-99.6	53.1	97.4	100	
Median			100.0	0.0	0	0	25.0	-66.0	-92.0	31.0	-67.0	-100.0	54.0	100.0	100	
Std Dev			0.0	0.0	0	0	1.5	1.3	0.5	2.1	2.1	0.8	2.3	6.8	0	
Mode			100.0	0.0	0	0	25.0	-67.0	-92.0	32.0	-66.0	-100.0	54.0	100.0	100	
5.2.12.1	120	0	100	0	0	0	29	-63	-92	31	-68	-99	48	100	100	Web cmd
5.2.12.2	120	30	100	0	0	0	30	-62	-91	30	-68	-99	48	100	100	
5.2.12.3	120	60	100	0	0	0	29	-61	-91	31	-67	-99	36	100	100	
5.2.12.4	120	90	100	0	0	0	30	-62	-91	32	-67	-100	36	100	100	
5.2.12.5	120	120	100	0	0	0	30	-62	-93	32	-67	-100	48	100	100	
5.2.12.6	120	150	100	0	0	0	31	-62	-92	30	-67	-100	48	100	90	
5.2.12.7	120	180	100	0	0	0	29	-62	-90	32	-66	-100	36	100	100	
Avg			100.0	0.0	0	0	29.7	-62.0	-91.4	31.1	-67.1	-99.6	42.9	100.0	98.57143	
Median			100.0	0.0	0	0	30.0	-62.0	-91.0	31.0	-67.0	-100.0	48.0	100.0	100	
Std Dev			0.0	0.0	0	0	0.8	0.6	1.0	0.9	0.7	0.5	6.4	0.0	4	
Mode			100.0	0.0	0	0	29.0	-62.0	-91.0	32.0	-67.0	-100.0	48.0	100.0	100	
5.2.13.1	130	0	100	0	0	0	25	-66	-91	26	-71	-98	54	100	100	Web cmd
5.2.13.2	130	30	91	8	0	0	24	-67	-91	28	-71	-99	54	100	100	
5.2.13.3	130	60	89	10	0	0	26	-65	-92	28	-70	-100	54	90	100	
5.2.13.4	130	90	89	10	0	0	27	-65	-92	29	-70	-100	54	100	100	
5.2.13.5	130	120	91	8	0	0	25	-65	-90	30	-68	-100	54	89	100	
5.2.13.6	130	150	93	6	0	0	28	-64	-92	29	-68	-100	54	100	100	
5.2.13.7	130	180	93	6	0	0	28	-64	-92	29	-68	-100	54	87	100	
Avg			92.3	6.9	0	0	26.1	-65.1	-91.4	28.4	-69.4	-99.6	54.0	95.1	100	
Median			91.0	8.0	0	0	26.0	-65.0	-92.0	29.0	-70.0	-100.0	54.0	100.0	100	
Std Dev			3.8	3.4	0	0	1.6	1.1	0.8	1.3	1.4	0.8	0.0	6.1	0	
Mode			91.0	8.0	0	0	25.0	-65.0	-92.0	29.0	-68.0	-100.0	54.0	100.0	100	
5.2.14.1	140	0	9	90	0	0	22	-95	-92	25	-98	-100	54	90	100	Web cmd
5.2.14.2	140	30	48	51	0	0	23	-70	-91	24	-73	-100	54	100	100	
5.2.14.3	140	60	50	49	0	0	24	-68	-92	27	-71	-100	54	100	100	
5.2.14.4	140	90	61	38	0	0	23	-69	-92	28	-71	-100	54	100	100	
5.2.14.5	140	120	67	32	0	0	23	-69	-91	27	-72	-100	54	100	100	
5.2.14.6	140	150	72	27	0	0	25	-67	-92	29	-70	-100	54	100	100	
5.2.14.7	140	180	77	22	0	0	25	-67	-92	28	-70	-100	54	100	100	
Avg			54.9	44.1	0	0	23.6	-72.1	-91.7	26.9	-75.0	-100.0	54.0	98.6	100	
Median			61.0	38.0	0	0	23.0	-69.0	-92.0	27.0	-71.0	-100.0	54.0	100.0	100	
Std Dev			22.9	22.9	0	0	1.1	10.1	0.5	1.8	10.2	0.0	0.0	3.8	0	
Mode			#N/A	#N/A	0	0	23.0	-69.0	-92.0	27.0	-71.0	-100.0	54.0	100.0	100	
5.2.15.1	150	0	14	85	0	0	20	-72	-93	25	-74	-98	48	100	100	Web cmd
5.2.15.2	150	30	3	60	28	7	22	-73	-94	21	-76	-99	36	100	100	
5.2.15.3	150	60	1	47	38	12	21	-72	-93	22	-76	-99	36	100	100	
5.2.15.4	150	90	1	40	40	17	19	-72	-91	20	-79	-99	36	100	100	
5.2.15.5	150	120	1	32	37	29	17	-74	-92	20	-78	-100	36	100	100	
5.2.15.6	150	150	1	30	34	33	19	-74	-92	19	-78	-100	36	100	100	
5.2.15.7	150	180	1	34	33	30	19	-72	-92	23	-76	-100	36	100	100	
Avg			3.1	46.9	30	18.29	19.6	-72.7	-92.4	21.4	-76.7	-99.3	37.7	100.0	100	
Median			1.0	40.0	34	17	19.0	-72.0	-92.0	21.0	-76.0	-99.0	36.0	100.0	100	
Std Dev			4.8	19.8	14	13	1.6	1.0	1.0	2.1	1.7	0.8	4.5	0.0	0	
Mode			1.0	#N/A	#N/A	#N/A	19.0	-72.0	-92.0	20.0	-76.0	-99.0	36.0	100.0	100	

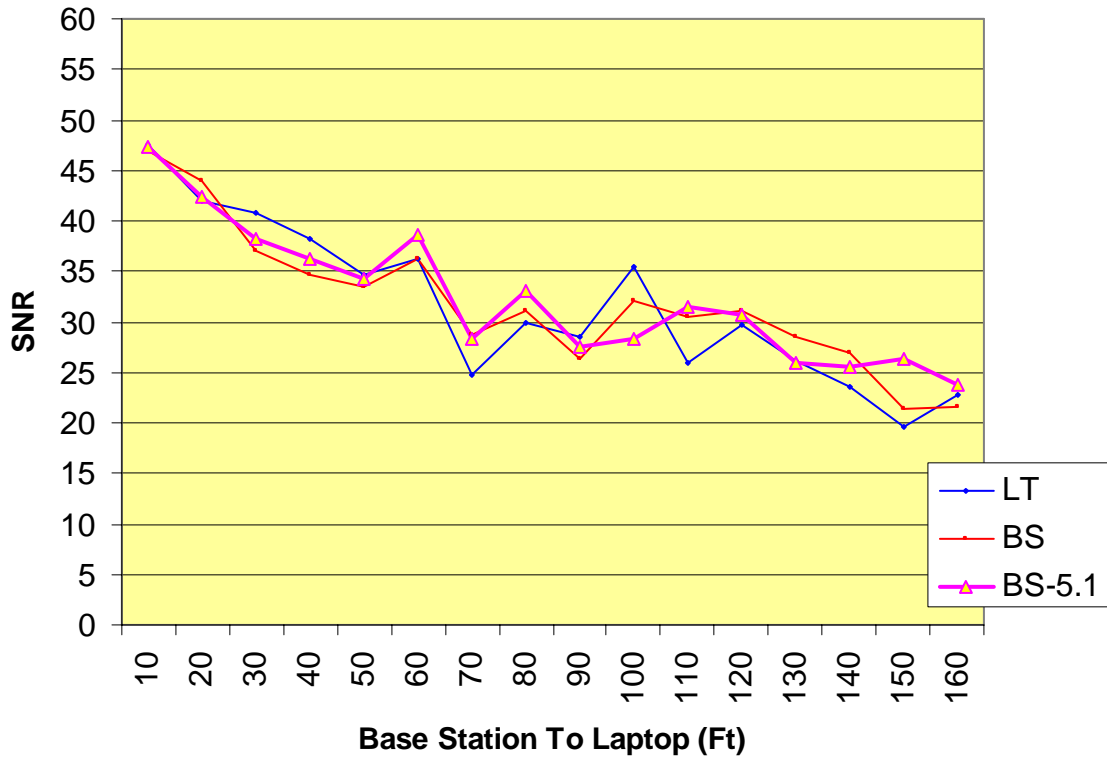
ECT Phase 2 – Vol. 2 – Appendices

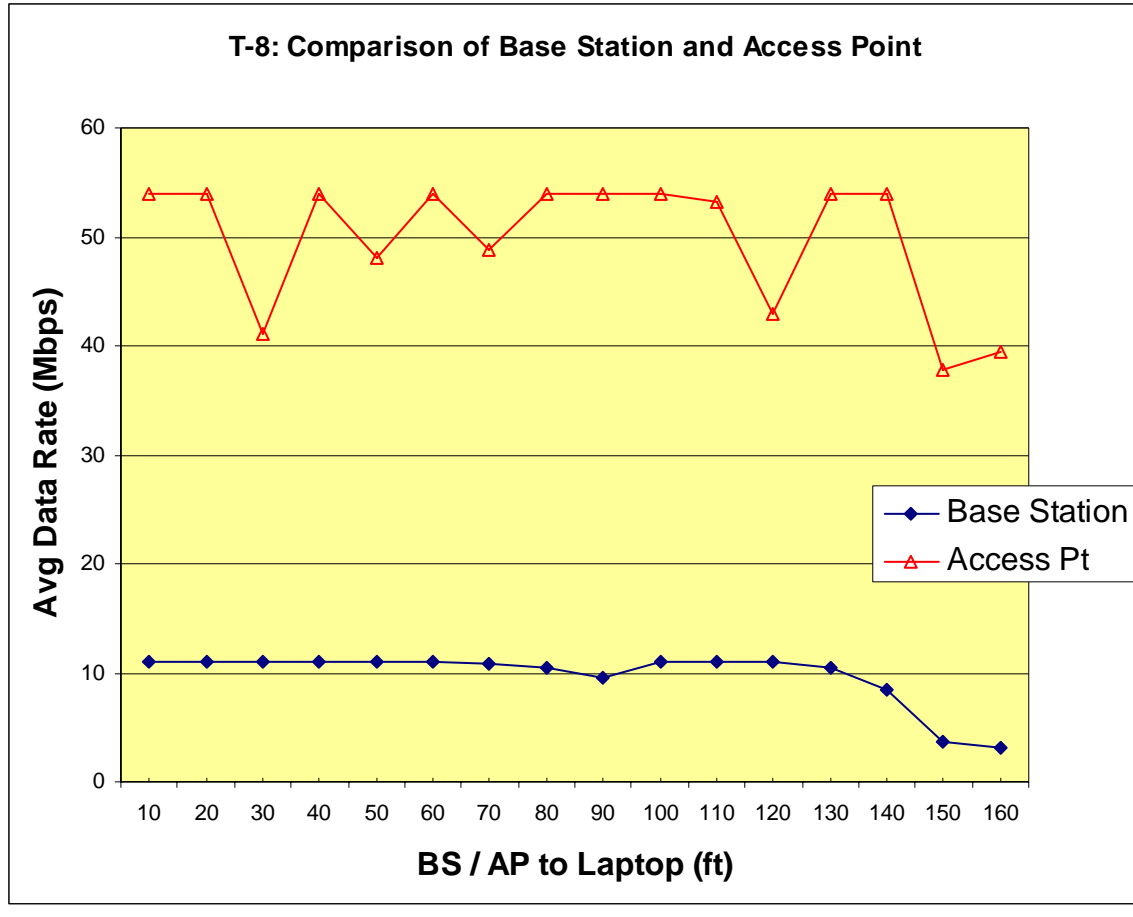
5.2.16.1	160	0	12	26	33	27	24	-68	-92	26	-72	-100	48	89	100	Web cmd
5.2.16.2	160	30	7	20	38	32	24	-70	-90	21	-78	-100	48	100	100	
5.2.16.3	160	60	8	30	37	23	22	-71	-92	21	-78	-100	36	88	95	
5.2.16.4	160	90	6	24	34	35	20	-70	-90	23	-76	-100	36	100	100	
5.2.16.5	160	120	5	20	33	35	23	-71	-94	21	-78	-100	36	88	96	
5.2.16.6	160	150	4	23	37	35	21	-70	-92	21	-76	-100	36	100	100	
5.2.16.7	160	180	4	22	37	36	26	-70	-94	18	-80	-100	36	100	100	
Avg			6.6	23.6	35.6	31.86	22.9	-70.0	-92.0	21.6	-76.9	-100.0	39.4	95.0	98.7	
Median			6.0	23.0	37.0	35	23.0	-70.0	-92.0	21.0	-78.0	-100.0	36.0	100.0	100.0	
Std Dev			2.8	3.6	2.1	5	2.0	1.0	1.6	2.4	2.5	0.0	5.9	6.2	2.2	
Mode			4.0	20.0	37.0	35	24.0	-70.0	-92.0	21.0	-78.0	-100.0	36.0	100.0	100.0	

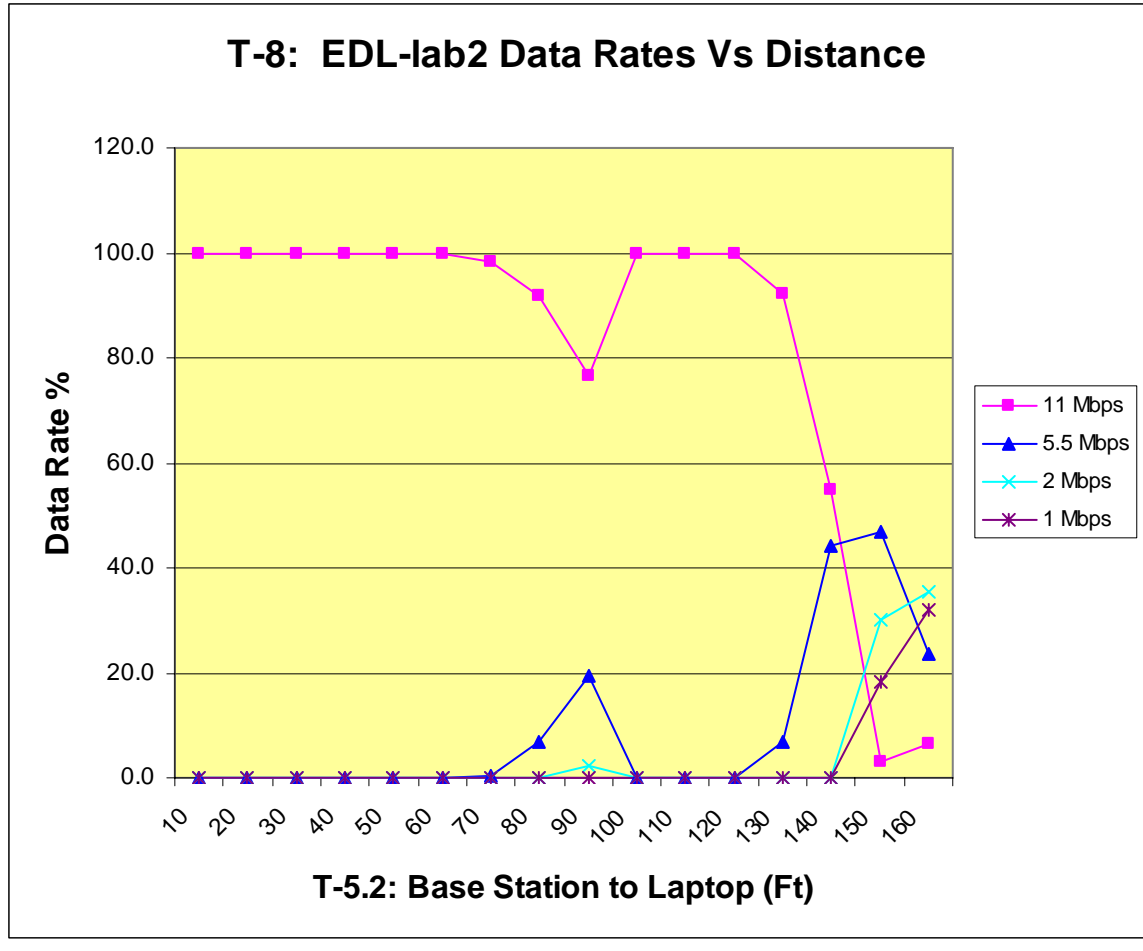
ECT Phase 2 – Vol. 2 – Appendices

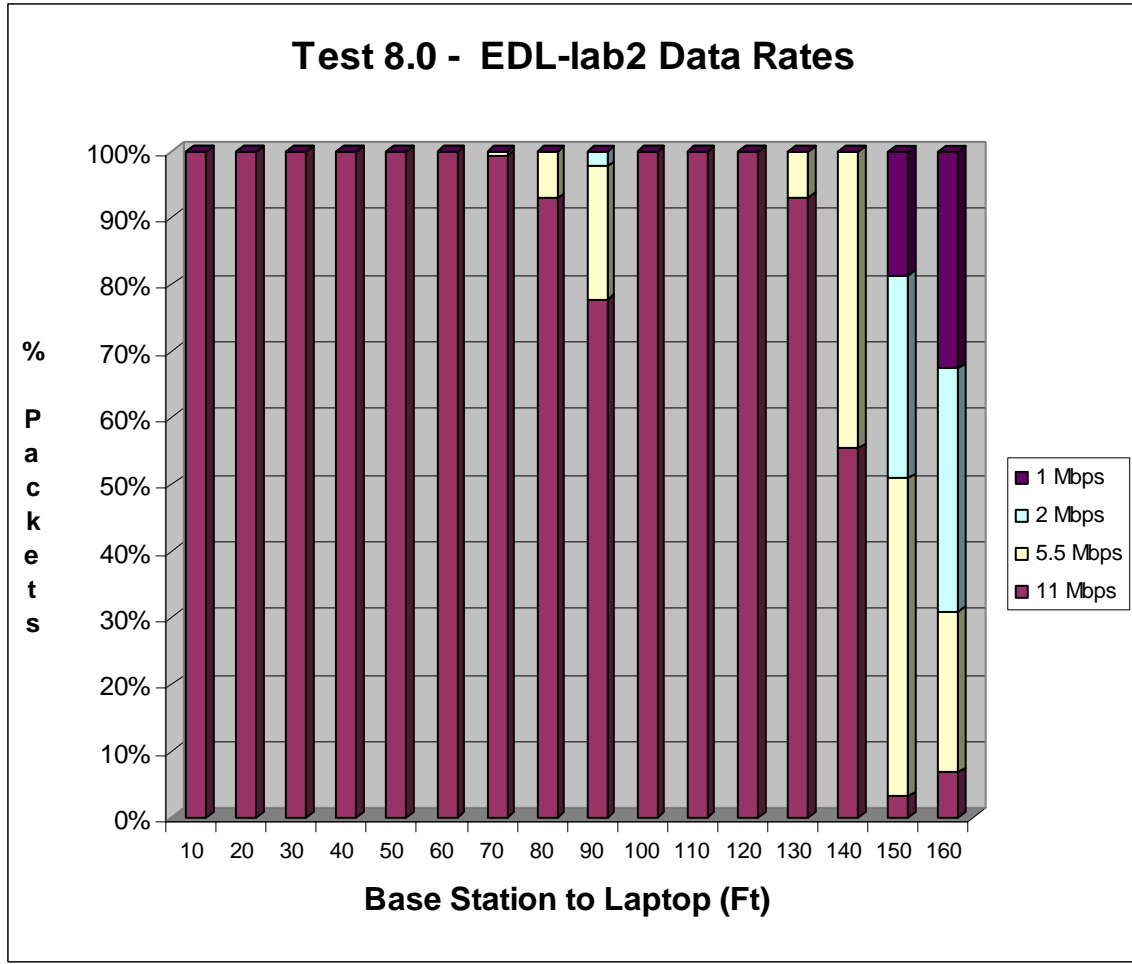
WiFi Average Performance With Distance (EDL-lab2)																
Test	8	Average														
Date	8/28/03				Time	0415										
Location				EDL first floor hall & parking lot												
Test Coordinator:				W. Harris												
Test Personnel:				Gary Bastin												
Hardware:				Laptop	#BH		Base station:		EDL-lab1							
Address:				00-02-2D-6E-A2-F4				00-50-F2-C7-21-6C								
Encryption (WEP):				128 bit				Firewall:		on		Pings:	Open			
Test Equipment:				Laptop built-in measuring software												
Antenna:				Rear-12:00 (Vertical)												
Distance:				Variable												
		BS & Laptop					Laptop			Base station			Access Point			Comments
Run	Dist	Avg	Speed (Mbps)				SNR	Signal	Noise	SNR	Signal	Noise	Speed (Mbps)			
		Mbps	11	5.5	2	1		dB	dB		dB	dB	Mbps	Qual	Strength	
5.2.1	10	11.0	100.0	0.0	0.0	0.0	47.4	-44.4	-91.7	46.9	-52.1	-100.0	54.0	100.0	100.0	
5.2.2	20	11.0	100.0	0.0	0.0	0.0	42.0	-49.0	-90.0	44.0	-54.0	-100.0	54.0	97.6	100.0	
5.2.3	30	11.0	100.0	0.0	0.0	0.0	40.7	-50.7	-91.4	37.0	-61.4	-100.0	41.1	95.6	98.1	
5.2.4	40	11.0	100.0	0.0	0.0	0.0	38.1	-53.9	-91.4	34.6	-63.7	-100.0	54.0	94.1	100.0	
5.2.5	50	11.0	100.0	0.0	0.0	0.0	34.7	-57.4	-92.0	33.4	-64.4	-100.0	48.0	100.0	84.7	
5.2.6	60	11.0	100.0	0.0	0.0	0.0	36.3	-55.7	-91.7	36.1	-62.6	-100.0	54.0	97.7	100.0	
5.2.7	70	10.9	98.4	0.6	0.0	0.0	24.7	-67.1	-91.9	28.7	-69.4	-100.0	48.9	100.0	100.0	
5.2.8	80	10.5	92.0	7.0	0.0	0.0	30.0	-61.7	-91.7	31.1	-67.1	-99.9	54.0	98.0	100.0	
5.2.9	90	9.6	76.7	19.6	2.3	0.0	28.4	-63.4	-91.7	26.3	-71.7	-99.7	54.0	96.9	100.0	
5.2.10	100	11.0	100.0	0.0	0.0	0.0	35.4	-56.4	-91.6	32.0	-66.1	-99.7	54.0	97.7	100.0	
5.2.11	110	11.0	100.0	0.0	0.0	0.0	25.9	-65.6	-91.7	30.6	-67.4	-99.6	53.1	97.4	100.0	
5.2.12	120	11.0	100.0	0.0	0.0	0.0	29.7	-62.0	-91.4	31.1	-67.1	-99.6	42.9	100.0	98.6	
5.2.13	130	10.5	92.3	6.9	0.0	0.0	26.1	-65.1	-91.4	28.4	-69.4	-99.6	54.0	95.1	100.0	
5.2.14	140	8.5	54.9	44.1	0.0	0.0	23.6	-72.1	-91.7	26.9	-75.0	-100.0	54.0	98.6	100.0	
5.2.15	150	3.7	3.1	46.9	30.0	18.3	19.6	-72.7	-92.4	21.4	-76.7	-99.3	37.7	100.0	100.0	
5.2.16	160	3.0	6.6	23.6	35.6	31.9	22.9	-70.0	-92.0	21.6	-76.9	-100.0	39.4	95.0	98.7	

T-8: EDL-lab1 Average SNR With Distance









Test Procedure

This document identifies the procedures to be conducted to satisfy the test requirements of the Ultra Wide Band transceivers and signal generator tag equipment acquired from Time Domain Corporation, Huntsville, AL. This document is a required deliverable, as part of FY03 Task Order Ref.: 6CNT, TO No.: 241

Basic

03/03/03 1:06 PM

NASA Project Manager

Table of Contents

**(Individual Table of Contents had to be removed to avoid conflicts with
Volume 2's overall Table of Contents)**

1.0 INTRODUCTION

The procedures outlined in this document describe the steps necessary to meet the testing requirements set forth in the Ultra Wide Band Transceiver and Signal Generator Tag Test Plan.

2.0 TEST DESCRIPTION

Five separate tests will be performed, testing the capabilities of the UWB transceivers and possible interference with or interference from other equipment. The interference sources have been identified as Iridium Satellite Telephones, Cordless Telephones, Wi-Fi equipped laptop computers, FM broadcast receivers, portable televisions, VHF FM Transmitters and GPS receivers. Interference from the UWB transceivers on each of these devices will also be tested.

Each test will be performed over varying distances between the UWB transmitters. See Table 2.1 for details.

3.0 REQUIRED EQUIPMENT

To adequately test the UWB transceivers the following equipment will be required:

- Two laptop computers with the Time Domain EVK applications installed.
- Two RS-232 cables to connect the laptops and the UWB transceivers.
- Two Category 5 Ethernet cables to connect the laptops to the UWB Transceivers.
- Two UWB transceivers.
- One RF spectrum analyzer with antenna.
- Two Wi-Fi Network interfaces for the above laptops.
- Two Two-Way Radios
- One portable television set.
- One broadcast FM receiver.
- One cordless telephone.
- One Iridium satellite telephone.
- One GPS receiver.
- One measuring tape.

Tests	Nominal Data Rate	Range (ft.)	Measurement	Comments
Range vs. Data Rate (Range measured between the two transceivers)	9.6 Mb/s 2.4 Mb/s 600 Kb/s 150 Kb/s 75 Kb/s	5 through 200 (see individual tests)	EVK Statistics	Signal Generator Tag Running during all measurements.
Interference vs. Data Rate vs. Range (Interference sources include: Iridium Satellite Phone, Wi-Fi equipped laptops, FM Transmitter (1.5W), cordless phone)	9.6 Mb/s 2.4 Mb/s 600 Kb/s 150 Kb/s 75 Kb/s	5 through 40 (see individual tests)		Signal Generator Tag Running during all measurements.
Link Margin vs. Data Rate vs. Range (Attenuation to include: stacked cinder block wall, normal interior wall in building, an office cubical wall divider, etc.)	9.6 Mb/s 2.4 Mb/s 600 Kb/s 150 Kb/s 75 Kb/s	5 through 40 (see individual tests)		Signal Generator Tag Running during all measurements.
Interference vs. Data Rate vs. Range (Susceptible items to include: laptop with and w/o Wi-Fi, FM broadcast receiver, portable TV, GPS Receiver, etc.)	9.6 Mb/s 2.4 Mb/s 600 Kb/s 150 Kb/s 75 Kb/s	5 through 40 (see individual tests)		
Gross Conformance to FCC Part 15 Subpart F Par. (3) Radiated Emissions Mask	9.6 Mb/s 2.4 Mb/s 600 Kb/s 150 Kb/s 75 Kb/s	Distance of 3 meters, or closer (if required for sensitivity); Note: dBuV/m = dBm + 95.2 + appropriate cal factors (antenna factors, AF, + distance factors, DF)	Composite Bandwidth Peak Emissions measured in dBuV/m. (Repeat for Vertical, Horizontal Polarization.)	Spectrum Analyzer Settings: RBW: 1 MHz VBW: 3 MHz Max Hold. Freq.: 3.0 to 11.0 GHz; Ant: TBD, linear polarization.

Table 3.1 UWB Test Configurations

4.0 **TEST PROCEDURES**

The procedures outlined below configure the PulsON 200 Performance Analysis software to perform the required tests described in Table 2-1. All testing will be accomplished with the test equipment configured as in Figure 4. The RS-232 cables are terminated with a male and a female DB-9 connector and should be approximately six feet in length. The Category 5 Ethernet cables are terminated with RJ-45 at each end.

There are no physical connections between the Signal Generator/Tag device and the spectrum analyzer with any other devices in the test configuration. All of the devices in the test configuration require 110 volts AC.

Insure that the UWB transceivers are running the latest software and firmware.

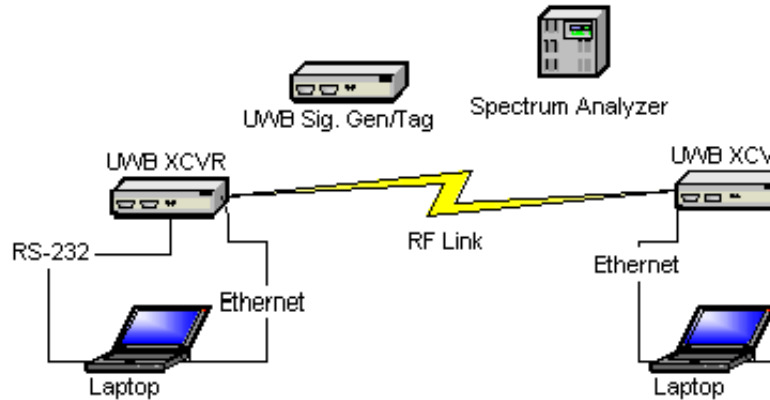


Figure 4

4.1 TIME DOMAIN EVK SOFTWARE CONFIGURATION

The PulsON 200 Performance Analysis Tool sets the UWB transceivers to the desired configuration and provides a real-time display of the quantity and quality of the data transferred between the transmitter and receiver.

After double clicking on the PulsON 200 Performance Analysis Tool icon the window similar to Figure 4.1 will appear.

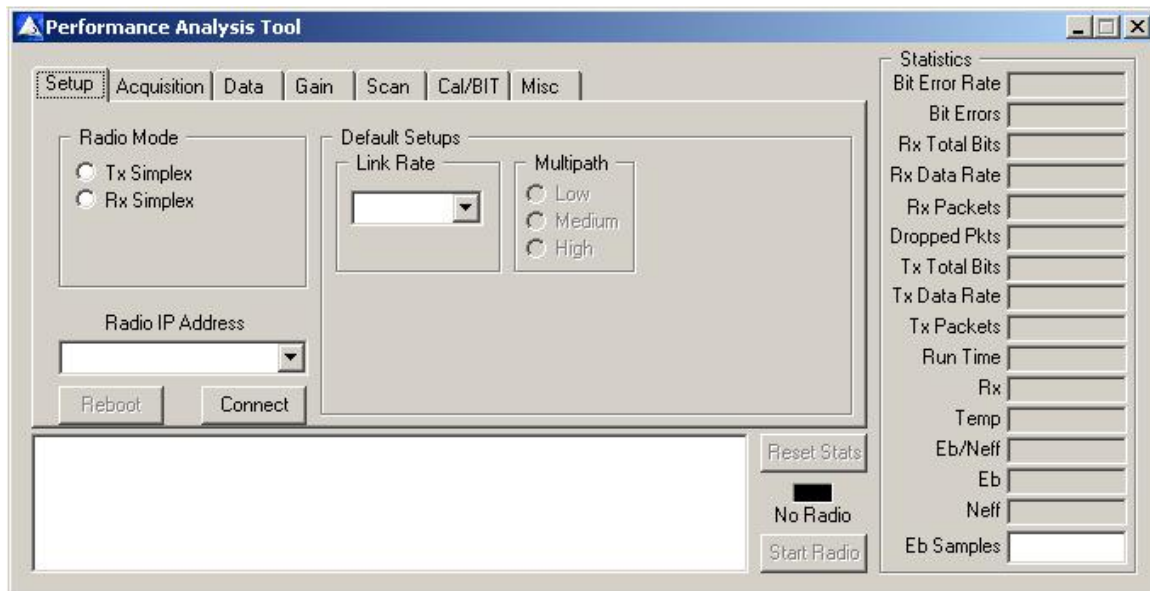


Figure 4.1

Referring to the Time Domain documentation: Configure one of the UWB transceivers as a receiver and the other as a transmitter. For each test documented below set the data rate and record the statistics as directed. It may be necessary to vary the VGA Gain in order to achieve an acceptable Bit Error Rate. Note the setting used for each test.

4.2 RANGE VS. DATA RATE TESTS

The Range vs. Data Rate Tests exercise the throughput rates over various separations of the UWB transceivers. Reference Table 2-1 for the ranges and data rates.

4.2.1 9.6 Mb/s

As described in section 4.1, configure the UWB transceivers for a data rate of 9.6 Mb/s and reset the statistics. Start the radio and gather statistics for five minutes. Record the statistics for each separation in the Table 4.2.1.

<i>Range vs. Data Rate – 9.6 Mb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
Bit Error Rate	5.50E-008	2.70E-003	8.90E-004	1.80E-003
Bit Errors	108	4799177	1375573	3196979
Rx Total Bits	1.96E+009	1.80E+009	1.54E+009	1.82E+009
Rx Data Rate	6.02 Mb/s	5.96 Mb/s	5.11 Mb/s	6.02 Mb/s
Rx Packets	59694	54906	47049	55575
Dropped Packets	17	476	8390	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	325	302	302	303
Rx	99.90%	99.10%	84.90%	100.00%
Temp	47C	43.5C	43C	43.5C
Eb/Neff	15.9dB	18.6dB	18.3dB	15.1dB
Eb	32.93	42.44	41.03	40.2
Neff	17.05	23.86	22.76	25.07
VGA Gain	14	22	31	31

Table 4.2.1

<i>Range vs. Data Rate – 9.6 Mb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>50 feet</i>	<i>100 feet</i>	<i>150 feet</i>	<i>200 feet</i>
Bit Error Rate	1.50E-002	5.90E-004	2.90E-003	3.10E-003
Bit Errors	26817118	1063236	5274693	5435633
Rx Total Bits	1.82E+009	1.82E+009	1.81E+009	1.73E+009
Rx Data Rate	6.02 Mb/s	6.03 Mb/s	6.01 Mb/s	5.74 Mb/s
Rx Packets	55591	55337	55131	52076
Dropped Packets	59	0	206	2541
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	303	301	301	301
Rx	99.90%	100.00%	99.60%	95.40%
Temp	44.5C	43.8C	43.8C	44.3C
Eb/Neff	4.7dB	12.2dB	9.5dB	2.8dB
Eb	26.89	34.8	32.29	23.69
Neff	22.17	22.64	22.77	20.88
VGA Gain	31	31	31	31

Table 4.2.1 cont'd

4.2.2 2.4 Mb/s

As described in section 4.1, configure the UWB transceivers for a data rate of 2.4 Mb/s and reset the statistics. Start the radio and gather statistics for five minutes. Record the statistics for each separation in the Table 4.2.2.

<i>Range vs. Data Rate – 2.4 Mb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
Bit Error Rate	8.90E-004	4.00E-004	3.60E-005	7.30E-005
Bit Errors	564232	259750	22946	45966
Rx Total Bits	635926400	651342400	629661600	627595200
Rx Data Rate	2.08 Mb/s	2.09 Mb/s	2.08 Mb/s	2.09 Mb/s
Rx Packets	19388	19858	19197	19134
Dropped Packets	96	5	3	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	306	312	302	300
Rx	99.50%	99.90%	99.90%	100
Temp	47.0C	44.8C	43.8C	42.5C
Eb/Neff	13.2 dB	24.9 dB	23.3 dB	16.9 dB
Eb	34.51	57.37	54.18	45.87
Neff	21.28	32.44	30.91	28.93
VGA Gain	10	31	31	31

Table 4.2.2

<i>Range vs. Data Rate – 2.4 Mb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>50 feet</i>	<i>100 feet</i>	<i>150 feet</i>	<i>200 feet</i>
Bit Error Rate	1.50E-004	3.30E-005	6.90E-006	2.60E-005
Bit Errors	90457	21296	4493	16444
Rx Total Bits	623757600	641141600	647373600	625200800
Rx Data Rate	2.07 Mb/s	2.10 Mb/s	2.09 Mb/s	2.08 Mb/s
Rx Packets	19017	19547	19737	19061
Dropped Packets	158	1	36	92
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	301	306	310	301
Rx	99.20%	99.90%	99.80%	99.50%
Temp	43.8C	43.8C	86.8C	44.0C
Eb/Neff	13.8 dB	19.1 dB	15.0 dB	9.5 dB
Eb	41.33	47.53	45.18	37.13
Neff	27.54	28.48	30.16	27.63
VGA Gain	31	31	31	31

Table 4.2.2 cont'd

4.2.3 600 Kb/s

As described in section 4.1, configure the UWB transceivers for a data rate of 600 Kb/s and reset the statistics. Start the radio and gather statistics for five minutes. Record the statistics for each separation in the Table 4.2.3.

<i>Range vs. Data Rate – 600 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
Bit Error Rate	0	0	1.10E-005	7.00E-005
Bit Errors	0	0	1892	12214
Rx Total Bits	174988000	180793600	173905600	174036800
Rx Data Rate	577.52Kb/s	577.62Kb/s	577.76Kb/s	578.2Kb/s
Rx Packets	5335	5512	5302	5306
Dropped Packets	1	2	1	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	303	313	301	301
Rx	99.90%	99.90%	99.90%	100.00%
Temp	46.8C	46.5C	43.5C	42.3C
Eb/Neff	26.9 dB	28.6 dB	25.6 dB	19.5 dB
Eb	57.53	66.45	66.39	53.13
Neff	30.63	37.88	40.77	33.67
VGA Gain	14	31	31	31

Table 4.2.3

<i>Range vs. Data Rate – 600 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>50 feet</i>	<i>100 feet</i>	<i>150 feet</i>	<i>200 feet</i>
Bit Error Rate	2.30E-004	5.80E-004	0.00E+000	1.70E-008
Bit Errors	40033	100913	0	3
Rx Total Bits	174069600	172987200	174319200	174299200
Rx Data Rate	576.39 Kb/s	572.81 Kb/s	578.15 Kb/s	577.15 Kb/s
Rx Packets	5307	5274	5320	5314
Dropped Packets	11	47	0	6
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	302	302	301	302
Rx	99.80%	99.10%	100.00%	99.90%
Temp	43.5C	42.5C	44.0C	43.8C
Eb/Neff	17.3 dB	16.1 dB	16.8 dB	21.5 dB
Eb	53.46	50.86	51.82	56.12
Neff	36.11	34.77	35.02	34.57
VGA Gain	31	31	31	31

Table 4.2.3 cont'd

4.2.4 150 Kb/s

As described in section 4.1, configure the UWB transceivers for a data rate of 150 Kb/s and reset the statistics. Start the radio and gather statistics for five minutes. Record the statistics for each separation in the Table 4.2.4.

<i>Range vs. Data Rate – 150 Kb/s</i>				
<i>Statistic</i>	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	0	0	1.00E-007	7.70E-004
<i>Bit Errors</i>	0	0	4	30715
<i>Rx Total Bits</i>	38638400	41328000	39688000	39983200
<i>Rx Data Rate</i>	127.94 Kb/s	132.04 Kb/s	131.85 Kb/s	132.39 Kb/s
<i>Rx Packets</i>	1178	1260	1210	1219
Dropped Packets	40	2	6	2
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	302	313	301	302
Rx	96.70%	99.80%	99.50%	99.80%
Temp	47.0C	46.8C	42.8C	42.8C
Eb/Neff	22.9 dB	27.4 dB	25.9 dB	26.5 dB
Eb	58.92	81	77.09	69.97
Neff	36	53.56	51.21	43.5
VGA Gain	11	31	31	31

Table 4.2.4

<i>Range vs. Data Rate – 150 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>50 feet</i>	<i>100 feet</i>	<i>150 feet</i>	<i>200 feet</i>
<i>Bit Error Rate</i>	4.50E-004	1.20E-003	0.00E+000	3.40E-007
<i>Bit Errors</i>	18059	46409	0	13
<i>Rx Total Bits</i>	39884800	38638400	38999200	38540000
<i>Rx Data Rate</i>	132.51 Kb/s	128.37 Kb/s	129.57 Kb/s	128.47 Kb/s
<i>Rx Packets</i>	1216	1178	1189	1175
Dropped Packets	0	38	27	39
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	301	301	301	300
Rx	100.00%	96.90%	97.80%	96.80%
Temp	43.8C	43.0C	44.0C	43.5C
Eb/Neff	23.1 dB	27.3 dB	25.9 dB	26.5 dB
Eb	66.15	77.59	73.67	68.66
Neff	43.07	50.33	47.73	42.18
VGA Gain	31	31	31	31

Table 4.2.4 cont'd

4.2.5 75 Kb/s

As described in section 4.1, configure the UWB transceivers for a data rate of 75 Kb/s and reset the statistics. Start the radio and gather statistics for five minutes. Record the statistics for each separation in the Table 4.2.5.

<i>Range vs. Data Rate – 75 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>10 feet</i>	<i>20 feet</i>	<i>30 feet</i>	<i>40 feet</i>
<i>Bit Error Rate</i>	0	0	4.10E-004	1.50E-004
<i>Bit Errors</i>	0	0	8749	3253
<i>Rx Total Bits</i>	26272800	20992000	21221600	21418400
<i>Rx Data Rate</i>	70.06 Kb/s	69.97 Kb/s	70.27 Kb/s	70.46 Kb/s
<i>Rx Packets</i>	801	640	647	653
<i>Dropped Packets</i>	3	4	2	0
<i>TX Total Bits</i>				
<i>TX Data Rate</i>				
<i>TX Packets</i>				
<i>Run Time</i>	375	300	302	304
<i>Rx</i>	99.60%	99.40%	99.70%	100.00%
<i>Temp</i>	47.0C	42.5C	42.8C	42.5C
<i>Eb/Neff</i>	26.8 dB	27.2 dB	28.2 dB	21.4 dB
<i>Eb</i>	87.06	80.4	76.18	66.53
<i>Neff</i>	60.22	53.17	48	45.09
<i>VGA Gain</i>	31	31	31	31

Table 4.2.5

<i>Range vs. Data Rate – 75 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>100 feet</i>	<i>200 feet</i>	<i>300 feet</i>	<i>400 feet</i>
<i>Bit Error Rate</i>	4.30E+007	0.00E+000	5.00E-004	The receiver would not acquire at this separation.
<i>Bit Errors</i>	9	0	7901	
<i>Rx Total Bits</i>	20729600	21057600	15875200	
<i>Rx Data Rate</i>	68.87 Kb/s	69.96 Kb/s	51.21 Kb/s	
<i>Rx Packets</i>	632	642	484	
Dropped Packets	11	5	177	
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	301	301	310	
Rx	98.30%	99.20%	73.20%	
Temp	43.5C	43.3C	43.8C	
Eb/Neff	29.2 dB	28.1 dB	24.5 dB	
Eb	84.44	74.59	68.71	
Neff	55.19	46.46	44.16	
VGA Gain	31	31	31	

Table 4.2.5 cont'd

4.3 INTERFERENCE FROM OTHER DEVICES VS. DATA RATE VS RANGE

This test verifies proper operation of the UWB transceivers at various data rates and separations while in the presence of several different RF sources.

4.3.1 9.6 Mb/s

As described in section 4.1, configure the UWB transceivers for a data rate of 9.6 Mb/s and reset the statistics. Start the radio and gather statistics for five minutes.

In each test scenario activate the specified RF emitter for the duration of the test.

4.3.1.1 Iridium Telephone

Activate the Iridium Telephone, reset statistics and record the statistics for each separation in Table 4.3.1.1.

<i>Interference from Iridium Telephone vs. Data Rate vs. Range – 9.6 Mb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	5.50E-008	2.70E-003	8.90E-004	1.80E-003
<i>Bit Errors</i>	108	4799177	1375573	3196979
<i>Rx Total Bits</i>	1.96E+009	1.80E+009	1.54E+009	1.82E+009
<i>Rx Data Rate</i>	6.02 Mb/s	5.96 Mb/s	5.11 Mb/s	6.02 Mb/s
<i>Rx Packets</i>	59691	54900	47044	55576
Dropped Packets	20	482	8395	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	325	302	302	303
Rx	99.90%	99.10%	84.90%	100.00%
Temp	47C	43.5C	43C	43.5C
Eb/Neff	15.9dB	18.6dB	18.5dB	15.1dB
Eb	32.89	42.45	41.13	40.15
Neff	16.95	23.8	22.66	25.04
VGA Gain	14	22	31	31

Table 4.3.1.1

4.3.1.2 Wi-Fi Equipped Laptop

Activate the Wi-Fi equipped laptops, reset statistics and record the statistics for each separation in Table 4.3.1.2.

<i>Interference from Wi-Fi Equipped Laptop vs. Data Rate vs. Range – 9.6 Mb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	<p>All tests were conducted with an active Wi-Fi equipped laptop in close proximity to the UWB receiver. No interference was detected at any of the specified ranges.</p>			
<i>Bit Errors</i>				
<i>Rx Total Bits</i>				
<i>Rx Data Rate</i>				
<i>Rx Packets</i>				
Dropped Packets				
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time				
Rx				
Temp				
Eb/Neff				
Eb				
Neff				
VGA Gain				

Table 4.3.1.2

4.3.1.3 FM Transmitter

Activate the FM Transmitter, reset statistics and record the statistics for each separation in Table 4.3.1.3.

<i>Interference from FM Transmitter vs. Data Rate vs. Range – 9.6 Mb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	5.50E-008	2.70E-003	8.90E-004	1.80E-003
<i>Bit Errors</i>	108	4799177	1375573	3196979
<i>Rx Total Bits</i>	1.96E+009	1.80E+009	1.54E+009	1.82E+009
<i>Rx Data Rate</i>	6.02 Mb/s	5.96 Mb/s	5.11 Mb/s	6.02 Mb/s
<i>Rx Packets</i>	59696	54902	47089	55581
Dropped Packets	15	480	8350	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	325	302	302	303
Rx	99.90%	99.10%	84.90%	100.00%
Temp	47C	43.5C	43C	43.5C
Eb/Neff	15.7dB	18.5dB	18.4dB	16.1dB
Eb	32.88	42.4	40.9	40.27
Neff	17.15	23.88	22.5	24.17
VGA Gain	14	22	31	31

Table 4.3.1.3

4.3.1.4 Cordless Telephone

Activate the Cordless Telephone, reset statistics and record the statistics for each separation in Table 4.3.1.4.

<i>Interference from Cordless Telephone vs. Data Rate vs. Range – 9.6 Mb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	5.50E-008	2.70E-003	8.90E-004	1.80E-003
<i>Bit Errors</i>	108	4799177	1375573	3196979
<i>Rx Total Bits</i>	1.96E+009	1.80E+009	1.54E+009	1.82E+009
<i>Rx Data Rate</i>	6.02 Mb/s	5.96 Mb/s	5.11 Mb/s	6.02 Mb/s
<i>Rx Packets</i>	59701	54901	47079	55585
Dropped Packets	10	481	8360	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	325	302	302	303
Rx	99.90%	99.10%	84.90%	100.00%
Temp	47C	43.5C	43C	43.5C
Eb/Neff	15.8d	18.6dB	18.1dB	15.1dB
Eb	32.98	42.48	41.32	40.52
Neff	17.15	23.84	23.16	25.45
VGA Gain	14	22	31	31

Table 4.3.1.4

4.3.2 2.4 Mb/s

As described in section 4.1, configure the UWB transceivers for a data rate of 2.4 Mb/s and reset the statistics. Start the radio and gather statistics for five minutes.

In each test scenario activate the specified RF emitter for the duration of the test.

4.3.2.1 Iridium Telephone

Activate the Iridium Telephone, reset statistics and record the statistics for each separation in Table 4.3.2.1.

<i>Interference from Iridium Telephone vs. Data Rate vs. Range – 2.4 Mb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	8.90E-004	4.00E-004	3.60E-005	7.30E-005
<i>Bit Errors</i>	564232	259750	22946	45966
<i>Rx Total Bits</i>	635926400	651342400	629661600	627595200
<i>Rx Data Rate</i>	2.08 Mb/s	2.09 Mb/s	2.08 Mb/s	2.09 Mb/s
<i>Rx Packets</i>	19383	19854	19199	19137
Dropped Packets	101	9	3	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	306	312	302	300
Rx	99.50%	99.90%	99.90%	100
Temp	47.0C	44.8C	43.8C	42.5C
Eb/Neff	13.2 dB	24.9 dB	23.4 dB	16.9 dB
Eb	34.47	57.39	54.2	45.89
Neff	21.23	32.4	30.81	28.95
VGA Gain	10	31	31	31

Table 4.3.2.1

4.3.2.2 Wi-Fi Equipped Laptop

Activate the Wi-Fi equipped laptops, reset statistics and record the statistics for each separation in Table 4.3.2.2.

<i>Interference from Wi-Fi Equipped Laptop vs. Data Rate vs. Range – 2.4 Mb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	<p>All tests were conducted with an active Wi-Fi equipped laptop in close proximity to the UWB receiver. No interference was detected at any of the specified ranges.</p>			
<i>Bit Errors</i>				
<i>Rx Total Bits</i>				
<i>Rx Data Rate</i>				
<i>Rx Packets</i>				
Dropped Packets				
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time				
Rx				
Temp				
Eb/Neff				
Eb				
Neff				
VGA Gain				

Table 4.3.2.2

4.3.2.3 FM Transmitter

Activate the FM Transmitter, reset statistics and record the statistics for each separation in Table 4.3.2.3.

<i>Interference from FM Transmitter vs. Data Rate vs. Range – 2.4 Mb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	8.90E-004	4.00E-004	3.60E-005	7.30E-005
<i>Bit Errors</i>	564232	259750	22946	45966
<i>Rx Total Bits</i>	635926400	651342400	629661600	627595200
<i>Rx Data Rate</i>	2.08 Mb/s	2.09 Mb/s	2.08 Mb/s	2.09 Mb/s
<i>Rx Packets</i>	19401	19862	19198	19136
Dropped Packets	84	1	3	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	306	312	302	300
Rx	99.50%	99.90%	99.90%	100
Temp	48.1C	44.6C	43.4C	42.8C
Eb/Neff	13.2 dB	24.9 dB	23.4 dB	16.9 dB
Eb	34.66	57.59	54.27	45.78
Neff	21.46	32.69	30.87	28.88
VGA Gain	10	31	31	31

Table 4.3.2.3

4.3.2.4 Cordless Telephone

Activate the Cordless Telephone, reset statistics and record the statistics for each separation in Table 4.3.2.4.

<i>Interference from Cordless Telephone vs. Data Rate vs. Range – 2.4 Mb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	8.90E-004	4.00E-004	3.60E-005	7.30E-005
<i>Bit Errors</i>	564232	259750	22946	45966
<i>Rx Total Bits</i>	635926400	651342400	629661600	627595200
<i>Rx Data Rate</i>	2.08 Mb/s	2.09 Mb/s	2.08 Mb/s	2.09 Mb/s
<i>Rx Packets</i>	19399	19863	19199	19134
Dropped Packets	86	0	2	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	300	300	302	300
Rx	99.50%	100.00%	99.90%	100
Temp	44.1C	48.6C	45.4C	44.8C
Eb/Neff	13.2 dB	24.9 dB	23.4 dB	17.2 dB
Eb	34.6	57.79	55.29	46.28
Neff	21.44	32.89	31.87	29.05
VGA Gain	10	31	31	31

Table 4.3.2.4

4.3.3 600 Kb/s

As described in section 4.1, configure the UWB transceivers for a data rate of 600 Kb/s and reset the statistics. Start the radio and gather statistics for five minutes.

In each test scenario activate the specified RF emitter for the duration of the test.

4.3.3.1 Iridium Telephone

Activate the Iridium Telephone, reset statistics and record the statistics for each separation in Table 4.3.3.1.

<i>Interference from Iridium Telephone vs. Data Rate vs. Range – 600 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	2.30E-004	5.80E-004	0.00E+000	1.70E-008
<i>Bit Errors</i>	40033	100913	0	3
<i>Rx Total Bits</i>	174069600	172987200	174319200	174299200
<i>Rx Data Rate</i>	576.39 Kb/s	572.81 Kb/s	578.15 Kb/s	577.15 Kb/s
<i>Rx Packets</i>	5308	5272	5321	5313
Dropped Packets	10	49	0	7
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	302	302	301	302
Rx	99.80%	99.10%	100.00%	99.90%
Temp	43.5C	42.5C	44.0C	43.8C
Eb/Neff	13.2 dB	24.9 dB	23.4 dB	16.2 dB
Eb	34.61	57.8	55.3	46.32
Neff	21.44	32.89	31.87	30.12
VGA Gain	31	31	31	31

Table 4.3.3.1

4.3.3.2 Wi-Fi Equipped Laptop

Activate the Wi-Fi equipped laptops, reset statistics and record the statistics for each separation in Table 4.3.3.2.

<i>Interference from Wi-Fi Equipped Laptop vs. Data Rate vs. Range – 600 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	<p>All tests were conducted with an active Wi-Fi equipped laptop in close proximity to the UWB receiver. No interference was detected at any of the specified ranges.</p>			
<i>Bit Errors</i>				
<i>Rx Total Bits</i>				
<i>Rx Data Rate</i>				
<i>Rx Packets</i>				
Dropped Packets				
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time				
Rx				
Temp				
Eb/Neff				
Eb				
Neff				
VGA Gain				

Table 4.3.3.2

4.3.3.3 FM Transmitter

Activate the FM Transmitter, reset statistics and record the statistics for each separation in Table 4.3.3.3.

<i>Interference from FM Transmitter vs. Data Rate vs. Range – 600 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	2.30E-004	5.80E-004	0.00E+000	1.70E-008
<i>Bit Errors</i>	40033	100913	0	3
<i>Rx Total Bits</i>	174069600	172987200	174319200	174299200
<i>Rx Data Rate</i>	576.39 Kb/s	572.81 Kb/s	578.15 Kb/s	577.15 Kb/s
<i>Rx Packets</i>	5305	5271	5322	5315
Dropped Packets	13	50	0	6
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	302	302	301	302
Rx	99.80%	99.10%	100.00%	99.90%
Temp	43.5C	42.5C	44.0C	43.8C
Eb/Neff	17.3 dB	16.1 dB	16.8 dB	21.5 dB
Eb	53.46	50.86	51.82	56.12
Neff	36.11	34.77	35.02	34.57
VGA Gain	31	31	31	31

Table 4.3.3.3

4.3.3.4 Cordless Telephone

Activate the Cordless Telephone, reset statistics and record the statistics for each separation in Table 4.3.3.4.

<i>Interference from Cordless Telephone vs. Data Rate vs. Range – 600 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	2.30E-004	5.80E-004	0.00E+000	1.70E-008
<i>Bit Errors</i>	40033	100913	0	3
<i>Rx Total Bits</i>	174069600	172987200	174319200	174299200
<i>Rx Data Rate</i>	576.39 Kb/s	572.81 Kb/s	578.15 Kb/s	577.15 Kb/s
<i>Rx Packets</i>	5300	5276	5326	5311
Dropped Packets	10	45	0	2
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	302	302	301	302
Rx	99.80%	99.10%	100.00%	99.90%
Temp	43.5C	42.5C	44.0C	43.8C
Eb/Neff	17.3 dB	16.1 dB	16.8 dB	21.5 dB
Eb	53.46	50.86	51.82	56.12
Neff	36.11	34.77	35.02	34.57
VGA Gain	31	31	31	31

Table 4.3.3.4

4.3.4 150 Kb/s

As described in section 4.1, configure the UWB transceivers for a data rate of 150 Kb/s and reset the statistics. Start the radio and gather statistics for five minutes.

In each test scenario activate the specified RF emitter for the duration of the test.

4.3.4.1 Iridium Telephone

Activate the Iridium Telephone, reset statistics and record the statistics for each separation in Table 4.3.4.1.

<i>Interference from Iridium Telephone vs. Data Rate vs. Range – 150 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	0	0	1.00E-007	7.70E-004
<i>Bit Errors</i>	0	0	3	30720
<i>Rx Total Bits</i>	38638400	41328000	39688000	39983200
<i>Rx Data Rate</i>	127.94 Kb/s	132.04 Kb/s	131.85 Kb/s	132.39 Kb/s
<i>Rx Packets</i>	1177	1261	1212	1216
Dropped Packets	41	2	6	2
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	302	313	301	302
Rx	96.70%	99.80%	99.50%	99.80%
Temp	47.0C	46.8C	42.8C	42.8C
Eb/Neff	22.9 dB	27.4 dB	25.9 dB	26.5 dB
Eb	58.9	81.03	77.19	69.94
Neff	35.99	53.59	51.3	43.47
VGA Gain	11	31	31	31

Table 4.3.4.1

4.3.4.2 Wi-Fi Equipped Laptop

Activate the Wi-Fi equipped laptops, reset statistics and record the statistics for each separation in Table 4.3.4.2.

<i>Interference from Wi-Fi Equipped Laptop vs. Data Rate vs. Range – 150 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	<p>All tests were conducted with an active Wi-Fi equipped laptop in close proximity to the UWB receiver. No interference was detected at any of the specified ranges.</p>			
<i>Bit Errors</i>				
<i>Rx Total Bits</i>				
<i>Rx Data Rate</i>				
<i>Rx Packets</i>				
Dropped Packets				
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time				
Rx				
Temp				
Eb/Neff				
Eb				
Neff				
VGA Gain				

Table 4.3.4.2

4.3.4.3 FM Transmitter

Activate the FM Transmitter, reset statistics and record the statistics for each separation in Table 4.3.4.3.

<i>Interference from FM Transmitter vs. Data Rate vs. Range – 150 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	0	0	1.00E-007	7.70E-004
<i>Bit Errors</i>	0	0	4	30715
<i>Rx Total Bits</i>	38638400	41328000	39688000	39983200
<i>Rx Data Rate</i>	127.94 Kb/s	132.04 Kb/s	131.85 Kb/s	132.39 Kb/s
<i>Rx Packets</i>	1175	1262	1212	1222
Dropped Packets	43	0	4	2
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	302	310	301	304
Rx	96.70%	100.00%	99.50%	99.80%
Temp	47.0C	46.8C	42.8C	42.8C
Eb/Neff	22.9 dB	27.4 dB	25.8 dB	26.5 dB
Eb	59.92	80.95	77.19	70.97
Neff	36.99	53.5	51.35	44.51
VGA Gain	11	31	31	31

Table 4.3.4.3

4.3.4.4 Cordless Telephone

Activate the Cordless Telephone, reset statistics and record the statistics for each separation in Table 4.3.4.4.

<i>Interference from Cordless Telephone vs. Data Rate vs. Range – 150 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	0	0	1.00E-007	7.70E-004
<i>Bit Errors</i>	0	0	4	30715
<i>Rx Total Bits</i>	38638400	41328000	39688000	39983200
<i>Rx Data Rate</i>	127.94 Kb/s	132.04 Kb/s	131.85 Kb/s	132.39 Kb/s
<i>Rx Packets</i>	1175	1258	1215	1222
Dropped Packets	43	0	1	2
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	302	306	300	304
Rx	96.70%	100.00%	99.90%	99.80%
Temp	47.0C	46.8C	42.8C	42.8C
Eb/Neff	22.9 dB	27.4 dB	25.9 dB	26.5 dB
Eb	58.17	80.87	77.29	69.89
Neff	36.25	53.48	51.43	43.41
VGA Gain	11	31	31	31

Table 4.3.4.4

4.3.5 75 Kb/s

As described in section 4.1, configure the UWB transceivers for a data rate of 75 Kb/s and reset the statistics. Start the radio and gather statistics for five minutes.

In each test scenario activate the specified RF emitter for the duration of the test.

4.3.5.1 Iridium Telephone

Activate the Iridium Telephone, reset statistics and record the statistics for each separation in Table 4.3.5.1.

<i>Interference from Iridium Telephone vs. Data Rate vs. Range – 75 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>10 feet</i>	<i>20 feet</i>	<i>30 feet</i>	<i>40 feet</i>
<i>Bit Error Rate</i>	0	0	4.10E-004	1.50E-004
<i>Bit Errors</i>	0	0	8749	3253
<i>Rx Total Bits</i>	26268800	20992000	21221600	21418400
<i>Rx Data Rate</i>	70.06 Kb/s	69.97 Kb/s	70.27 Kb/s	70.46 Kb/s
<i>Rx Packets</i>	645	642	649	653
Dropped Packets	2	4	2	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	300	300	302	303
Rx	99.70%	99.40%	99.70%	100.00%
Temp	47.0C	42.5C	42.8C	42.5C
Eb/Neff	26.8 dB	27.2 dB	28.2 dB	21.4 dB
Eb	87.26	80.42	76.38	66.73
Neff	60.42	53.19	48.16	45.29
VGA Gain	31	31	31	31

Table 4.3.5.1

4.3.5.2 Wi-Fi Equipped Laptop

Activate the Wi-Fi equipped laptops, reset statistics and record the statistics for each separation in Table 4.3.5.2.

<i>Interference from Wi-Fi Equipped Laptop vs. Data Rate vs. Range – 75 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>10 feet</i>	<i>20 feet</i>	<i>30 feet</i>	<i>40 feet</i>
<i>Bit Error Rate</i>	<p>All tests were conducted with an active Wi-Fi equipped laptop in close proximity to the UWB receiver. No interference was detected at any of the specified ranges.</p>			
<i>Bit Errors</i>				
<i>Rx Total Bits</i>				
<i>Rx Data Rate</i>				
<i>Rx Packets</i>				
<i>Dropped Packets</i>				
<i>TX Total Bits</i>				
<i>TX Data Rate</i>				
<i>TX Packets</i>				
<i>Run Time</i>				
<i>Rx</i>				
<i>Temp</i>				
<i>Eb/Neff</i>				
<i>Eb</i>				
<i>Neff</i>				
<i>VGA Gain</i>				

Table 4.3.5.2

4.3.5.3 FM Transmitter

Activate the FM Transmitter, reset statistics and record the statistics for each separation in Table 4.3.5.3.

<i>Interference from FM Transmitter vs. Data Rate vs. Range – 75 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>10 feet</i>	<i>20 feet</i>	<i>30 feet</i>	<i>40 feet</i>
<i>Bit Error Rate</i>	0	0	4.10E-004	1.50E-004
<i>Bit Errors</i>	0	0	8749	3253
<i>Rx Total Bits</i>	26268600	20992000	21221600	21418400
<i>Rx Data Rate</i>	70.0 Kb/s	69.97 Kb/s	70.27 Kb/s	70.46 Kb/s
<i>Rx Packets</i>	647	645	651	652
Dropped Packets	1	3	4	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	300	300	302	303
Rx	99.90%	99.50%	99.40%	100.00%
Temp	47.0C	42.5C	42.8C	42.5C
Eb/Neff	26.8 dB	27.2 dB	28.2 dB	21.4 dB
Eb	88.26	83.42	76.88	66.53
Neff	61.42	56.19	48.66	45.09
VGA Gain	31	31	31	31

Table 4.3.5.3

4.3.5.4 Cordless Telephone

Activate the Cordless Telephone, reset statistics and record the statistics for each separation in Table 4.3.5.4.

<i>Interference from Cordless Telephone vs. Data Rate vs. Range – 75 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>10 feet</i>	<i>20 feet</i>	<i>30 feet</i>	<i>40 feet</i>
<i>Bit Error Rate</i>	0	0	4.10E-004	1.50E-004
<i>Bit Errors</i>	0	0	8749	3253
<i>Rx Total Bits</i>	26268600	20992000	21221600	21418400
<i>Rx Data Rate</i>	70.0 Kb/s	69.97 Kb/s	70.27 Kb/s	70.46 Kb/s
<i>Rx Packets</i>	642	645	651	652
Dropped Packets	1	3	4	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	300	300	302	303
Rx	99.90%	99.50%	99.40%	100.00%
Temp	47.0C	42.5C	42.8C	42.5C
Eb/Neff	26.8 dB	27.2 dB	28.1 dB	21.3 dB
Eb	86.06	81.03	71.18	64.53
Neff	59.22	53.83	43.06	43.19
VGA Gain	31	31	31	31

Table 4.3.5.4

4.4 LINK MARGIN VS. DATA RATE VS. RANGE

This procedure tests the data rates vs. ranges with varying materials to shield the transceiver. These materials reflect substances found in a typical office environment. They include; a cinder block wall, a sheet rock (gypsum) wall and an office cubicle wall divider.

Reference Table 2-1 for the ranges and data rates.

4.4.1 9.6 MB/s

4.4.1.1 Stacked Cinder Block Wall

Shield the UWB Transmitter using stacked cinder blocks, reset statistics and record the statistics for each separation in Table 4.4.1.1.

<i>Cinder Block Shielding vs. Data Rate vs. Range – 9.6 Mb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	5.50E-008	2.70E-003	8.90E-004	1.80E-003
<i>Bit Errors</i>	108	4799177	1375573	3196979
<i>Rx Total Bits</i>	1.96E+009	1.80E+009	1.54E+009	1.82E+009
<i>Rx Data Rate</i>	6.02 Mb/s	5.96 Mb/s	5.11 Mb/s	6.02 Mb/s
<i>Rx Packets</i>	59690	54906	47549	55579
Dropped Packets	21	476	7890	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	301	302	302	303
Rx	99.90%	99.10%	85.70%	100.00%
Temp	47C	43.5C	43C	43.5C
Eb/Neff	15.9dB	18.6dB	18.3dB	15.1dB
Eb	33.88	42.41	41.33	41.2
Neff	18.01	23.83	23.06	26.05
VGA Gain	14	22	31	31

Table 4.4.1.1

4.4.1.2 Sheetrock Wall

Shield the UWB Transmitter using sheet rock, reset statistics and record the statistics for each separation in Table 4.4.1.2.

<i>Sheetrock Shielding vs. Data Rate vs. Range – 9.6 Mb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	5.50E-008	2.70E-003	8.90E-004	1.80E-003
<i>Bit Errors</i>	108	4799177	1375573	3196979
<i>Rx Total Bits</i>	1.96E+009	1.80E+009	1.54E+009	1.82E+009
<i>Rx Data Rate</i>	6.02 Mb/s	5.96 Mb/s	5.11 Mb/s	6.02 Mb/s
<i>Rx Packets</i>	54690	54916	47589	55570
Dropped Packets	25	466	7850	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	300	302	302	303
Rx	99.90%	99.10%	85.70%	100.00%
Temp	47C	43.5C	43C	43.5C
Eb/Neff	15.9dB	18.6dB	17.3dB	15.1dB
Eb	35.88	41.01	43.35	41.31
Neff	19.94	22.43	26.04	26.15
VGA Gain	14	22	31	31

Table 4.4.1.2

4.4.1.3 Cubicle Wall

Shield the UWB Transmitter using cubicle wall material, reset statistics and record the statistics for each separation in Table 4.4.1.3.

<i>Cubicle Wall Shielding vs. Data Rate vs. Range – 9.6 Mb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	5.50E-008	2.70E-003	8.90E-004	1.80E-003
<i>Bit Errors</i>	108	4799177	1375573	3196979
<i>Rx Total Bits</i>	1.96E+009	1.80E+009	1.54E+009	1.82E+009
<i>Rx Data Rate</i>	6.02 Mb/s	5.96 Mb/s	5.11 Mb/s	6.02 Mb/s
<i>Rx Packets</i>	54679	54725	47693	55623
Dropped Packets	21	703	8132	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	300	302	302	303
Rx	99.90%	99.10%	85.70%	100.00%
Temp	47C	43.5C	43C	43.5C
Eb/Neff	15.9dB	18.6dB	17.4dB	15.1dB
Eb	36.32	40.11	43.14	41.38
Neff	20.41	21.53	25.74	26.22
VGA Gain	14	22	31	31

Table 4.4.1.3

4.4.2 2.4 MB/s

4.4.2.1 Stacked Cinder Block Wall

Shield the UWB Transmitter using stacked cinder blocks, reset statistics and record the statistics for each separation in Table 4.4.2.1.

<i>Cinder Block Shielding vs. Data Rate vs. Range – 2.4 Mb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	8.90E-004	4.00E-004	3.60E-005	7.30E-005
<i>Bit Errors</i>	564232	259750	22946	45966
<i>Rx Total Bits</i>	635926400	651342400	629661600	627595200
<i>Rx Data Rate</i>	2.08 Mb/s	2.09 Mb/s	2.08 Mb/s	2.09 Mb/s
<i>Rx Packets</i>	19444	19523	19265	19287
Dropped Packets	88	0	2	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	300	300	302	300
Rx	99.50%	100.00%	99.90%	100.00%
Temp	44.1C	48.6C	45.4C	44.8C
Eb/Neff	13.2 dB	24.9 dB	23.3 dB	16.9 dB
Eb	34.71	57.57	54.38	45.57
Neff	21.48	32.64	31.11	28.63
VGA Gain	10	31	31	31

Table 4.4.2.1

4.4.2.2 Sheetrock Wall

Shield the UWB Transmitter using sheet rock, reset statistics and record the statistics for each separation in Table 4.4.2.2.

<i>Sheetrock Shielding vs. Data Rate vs. Range – 2.4 Mb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	8.90E-004	4.00E-004	3.60E-005	7.30E-005
<i>Bit Errors</i>	564232	259750	22946	45966
<i>Rx Total Bits</i>	635926400	651342400	629661600	627595200
<i>Rx Data Rate</i>	2.08 Mb/s	2.09 Mb/s	2.08 Mb/s	2.09 Mb/s
<i>Rx Packets</i>	19545	19518	19276	19305
Dropped Packets	98	0	2	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	300	300	302	300
Rx	99.50%	100.00%	99.90%	100
Temp	44.1C	48.6C	45.4C	44.8C
Eb/Neff	13.2 dB	24.9 dB	23.2 dB	16.9 dB
Eb	35.71	59.52	53.45	45.77
Neff	22.51	34.61	30.23	28.83
VGA Gain	10	31	31	31

Table 4.4.2.2

4.4.2.3 Cubicle Wall

Shield the UWB Transmitter using cubicle wall material, reset statistics and record the statistics for each separation in Table 4.4.2.3.

<i>Cubicle Wall Shielding vs. Data Rate vs. Range – 2.4 Mb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	8.90E-004	4.00E-004	3.60E-005	7.30E-005
<i>Bit Errors</i>	564232	259750	22946	45966
<i>Rx Total Bits</i>	635926400	651342400	629661600	627595200
<i>Rx Data Rate</i>	2.08 Mb/s	2.09 Mb/s	2.08 Mb/s	2.09 Mb/s
<i>Rx Packets</i>	19565	19548	19256	19325
Dropped Packets	91	0	2	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	300	300	302	300
Rx	99.50%	100.00%	99.90%	100
Temp	44.1C	48.6C	45.4C	44.8C
Eb/Neff	13.2 dB	24.9 dB	23.2 dB	16.9 dB
Eb	35.71	59.52	53.45	45.77
Neff	22.51	34.61	30.23	28.83
VGA Gain	10	31	31	31

Table 4.4.2.3

4.4.3 600 KB/s

4.4.3.1 Stacked Cinder Block Wall

Shield the UWB Transmitter using stacked cinder blocks, reset statistics and record the statistics for each separation in Table 4.4.3.1.

<i>Cinder Block Shielding vs. Data Rate vs. Range – 600 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	2.30E-004	5.80E-004	0.00E+000	1.70E-008
<i>Bit Errors</i>	40033	100913	0	3
<i>Rx Total Bits</i>	174069600	172987200	174319200	174299200
<i>Rx Data Rate</i>	576.39 Kb/s	572.81 Kb/s	578.15 Kb/s	577.15 Kb/s
<i>Rx Packets</i>	5321	5255	5332	5325
Dropped Packets	17	43	0	2
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	302	302	301	302
Rx	99.70%	99.10%	100.00%	99.90%
Temp	43.5C	42.5C	44.0C	43.8C
Eb/Neff	17.3 dB	16.1 dB	16.8 dB	21.5 dB
Eb	53.46	50.86	51.82	56.12
Neff	36.11	34.77	35.02	34.57
VGA Gain	31	31	31	31

Table 4.4.3.1

4.4.3.2 Sheetrock Wall

Shield the UWB Transmitter using sheet rock, reset statistics and record the statistics for each separation in Table 4.4.3.2.

<i>Sheetrock Shielding vs. Data Rate vs. Range – 600 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	2.30E-004	5.80E-004	0.00E+000	1.70E-008
<i>Bit Errors</i>	40033	100913	0	3
<i>Rx Total Bits</i>	174069600	172987200	174319200	174299200
<i>Rx Data Rate</i>	576.39 Kb/s	572.81 Kb/s	578.15 Kb/s	577.15 Kb/s
<i>Rx Packets</i>	5323	5251	5345	5337
Dropped Packets	19	38	0	2
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	302	302	301	302
Rx	99.60%	99.30%	100.00%	99.90%
Temp	43.5C	42.5C	44.0C	43.8C
Eb/Neff	17.3 dB	16.1 dB	16.8 dB	21.5 dB
Eb	53.46	50.86	51.82	56.12
Neff	36.11	34.77	35.02	34.57
VGA Gain	31	31	31	31

Table 4.4.3.2

4.4.3.3 Cubicle Wall

Shield the UWB Transmitter using cubicle wall material, reset statistics and record the statistics for each separation in Table 4.4.3.3.

<i>Cubicle Wall Shielding vs. Data Rate vs. Range – 600 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	2.30E-004	5.80E-004	0.00E+000	1.70E-008
<i>Bit Errors</i>	40033	100913	0	3
<i>Rx Total Bits</i>	174069600	172987200	174319200	174299200
<i>Rx Data Rate</i>	576.39 Kb/s	572.81 Kb/s	578.15 Kb/s	577.15 Kb/s
<i>Rx Packets</i>	5303	5231	5356	5339
Dropped Packets	14	32	0	2
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	302	302	301	302
Rx	99.70%	99.40%	100.00%	99.90%
Temp	43.5C	42.5C	44.0C	43.8C
Eb/Neff	17.3 dB	16.1 dB	16.8 dB	21.5 dB
Eb	53.46	50.86	51.82	56.12
Neff	36.11	34.77	35.02	34.57
VGA Gain	31	31	31	31

Table 4.4.3.3

4.4.4 150 KB/s

4.4.4.1 Stacked Cinder Block Wall

Shield the UWB Transmitter using stacked cinder blocks, reset statistics and record the statistics for each separation in Table 4.4.4.1.

<i>Cinder Block Shielding vs. Data Rate vs. Range – 150 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	0	0	1.00E-007	7.70E-004
<i>Bit Errors</i>	0	0	4	30715
<i>Rx Total Bits</i>	38638400	41328000	39688000	39983200
<i>Rx Data Rate</i>	127.94 Kb/s	132.04 Kb/s	131.85 Kb/s	132.39 Kb/s
<i>Rx Packets</i>	1202	1276	1232	1212
Dropped Packets	51	0	1	2
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	302	306	300	304
Rx	95.90%	100.00%	99.90%	99.80%
Temp	47.0C	46.8C	42.8C	42.8C
Eb/Neff	22.9 dB	27.4 dB	25.9 dB	26.5 dB
Eb	59.91	80	77.29	69.59
Neff	37.01	53.45	51.42	43.11
VGA Gain	11	31	31	31

Table 4.4.4.1

4.4.4.2 Sheetrock Wall

Shield the UWB Transmitter using sheet rock, reset statistics and record the statistics for each separation in Table 4.4.4.2.

<i>Sheetrock Shielding vs. Data Rate vs. Range – 150 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	0	0	1.00E-007	7.70E-004
<i>Bit Errors</i>	0	0	4	30715
<i>Rx Total Bits</i>	38638400	41328000	39688000	39983200
<i>Rx Data Rate</i>	127.94 Kb/s	132.04 Kb/s	131.85 Kb/s	132.39 Kb/s
<i>Rx Packets</i>	1241	1287	1239	1218
Dropped Packets	54	0	1	2
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	302	306	300	304
Rx	95.80%	100.00%	99.90%	99.80%
Temp	47.0C	46.8C	42.8C	42.8C
Eb/Neff	21.9 dB	26.5 dB	25.8 dB	25.9 dB
Eb	60.11	81.23	76.87	68.45
Neff	38.23	54.68	51.09	42.54
VGA Gain	11	31	31	31

Table 4.4.4.2

4.4.4.3 Cubicle Wall

Shield the UWB Transmitter using cubicle wall material, reset statistics and record the statistics for each separation in Table 4.4.4.3.

<i>Cubicle Wall Shielding vs. Data Rate vs. Range – 150 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>5 feet</i>	<i>10 feet</i>	<i>15 feet</i>	<i>20 feet</i>
<i>Bit Error Rate</i>	0	0	1.00E-007	7.70E-004
<i>Bit Errors</i>	0	0	4	30715
<i>Rx Total Bits</i>	38638400	41328000	39688000	39983200
<i>Rx Data Rate</i>	127.94 Kb/s	132.04 Kb/s	131.85 Kb/s	132.39 Kb/s
<i>Rx Packets</i>	1245	1281	1251	1253
Dropped Packets	51	0	1	2
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	302	306	300	304
Rx	95.10%	100.00%	99.90%	99.80%
Temp	47.0C	46.8C	42.8C	42.8C
Eb/Neff	22.9 dB	27.4 dB	25.8 dB	26.5 dB
Eb	57.84	81.27	77.33	70.01
Neff	34.91	53.85	51.57	43.56
VGA Gain	11	31	31	31

Table 4.4.4.3

4.4.5 75 KB/s

4.4.5.1 Stacked Cinder Block Wall

Shield the UWB Transmitter using stacked cinder blocks, reset statistics and record the statistics for each separation in Table 4.4.5.1.

<i>Cinder Block Shielding vs. Data Rate vs. Range – 75 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>10 feet</i>	<i>20 feet</i>	<i>30 feet</i>	<i>40 feet</i>
<i>Bit Error Rate</i>	0	0	4.10E-004	1.50E-004
<i>Bit Errors</i>	0	0	8749	3253
<i>Rx Total Bits</i>	26268600	20992000	21221600	21418400
<i>Rx Data Rate</i>	70.0 Kb/s	69.97 Kb/s	70.27 Kb/s	70.46 Kb/s
<i>Rx Packets</i>	646	644	653	651
Dropped Packets	1	2	5	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	300	300	302	303
Rx	99.60%	99.70%	99.20%	100.00%
Temp	47.0C	42.5C	42.8C	42.5C
Eb/Neff	26.8 dB	27.2 dB	28.1 dB	21.4 dB
Eb	87.25	80.44	76.48	66.51
Neff	60.47	53.21	48.41	45.07
VGA Gain	31	31	31	31

Table 4.4.5.1

4.4.5.2 Sheetrock Wall

Shield the UWB Transmitter using sheet rock, reset statistics and record the statistics for each separation in Table 4.4.5.2

<i>Sheetrock Shielding vs. Data Rate vs. Range – 75 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>10 feet</i>	<i>20 feet</i>	<i>30 feet</i>	<i>40 feet</i>
<i>Bit Error Rate</i>	0	0	4.10E-004	1.50E-004
<i>Bit Errors</i>	0	0	8749	3253
<i>Rx Total Bits</i>	26268600	20992000	21221600	21418400
<i>Rx Data Rate</i>	70.0 Kb/s	69.97 Kb/s	70.27 Kb/s	70.46 Kb/s
<i>Rx Packets</i>	649	643	650	650
Dropped Packets	1	2	5	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	300	300	302	303
Rx	99.90%	99.70%	99.20%	100.00%
Temp	47.0C	42.5C	42.8C	42.5C
Eb/Neff	26.8 dB	27.2 dB	28.2 dB	21.4 dB
Eb	87.26	80.43	76.23	66.58
Neff	60.42	53.2	48.05	45.14
VGA Gain	31	31	31	31

Table 4.4.5.2

4.4.5.3 Cubicle Wall

Shield the UWB Transmitter using cubicle wall material, reset statistics and record the statistics for each separation in Table 4.4.5.3.

<i>Cubicle Wall Shielding vs. Data Rate vs. Range – 75 Kb/s</i>				
<i>Statistic</i>	<i>Results</i>			
	<i>10 feet</i>	<i>20 feet</i>	<i>30 feet</i>	<i>40 feet</i>
<i>Bit Error Rate</i>	0	0	4.10E-004	1.50E-004
<i>Bit Errors</i>	0	0	8749	3253
<i>Rx Total Bits</i>	26268600	20992000	21221600	21418400
<i>Rx Data Rate</i>	70.0 Kb/s	69.97 Kb/s	70.27 Kb/s	70.46 Kb/s
<i>Rx Packets</i>	648	647	653	655
Dropped Packets	1	3	4	0
TX Total Bits				
TX Data Rate				
TX Packets				
Run Time	300	300	302	303
Rx	99.90%	99.50%	99.40%	100.00%
Temp	47.0C	42.5C	42.8C	42.5C
Eb/Neff	26.8 dB	26.3 dB	27.3 dB	21.4 dB
Eb	88.05	80.46	76.28	66.54
Neff	61.23	54.21	49.02	45.1
VGA Gain	31	31	31	31

Table 4.4.5.3

4.5 INTERFERENCE WITH OTHER DEVICES VS. DATA RATE VS. RANGE

This series of tests evaluates the susceptibility of several devices to interference from the UWB transceiver. In these scenarios the UWB transceiver will remain at a fixed separation of 10 feet and the device under test will be relocated to the distances depending on the tested data rate. **Testing of a particular device will cease when interference is no longer observed or the maximum distance is reached.** Interference is defined as any degradation in device performance directly attributable to the UWB transceiver(s).

<i>Data Rate</i>	<i>Distance Interference No Longer Observed (ft)</i>				
	<i>Laptop (Wi-Fi)</i>	<i>Laptop</i>	<i>FM Receiver</i>	<i>Television</i>	<i>GPS Receiver</i>
9.6 Mb/s	No interference detected.	No interference detected.	No interference detected.	No interference detected.	No interference detected.
2.4 Mb/s					
600 Kb/s					
150 KB/s					
75 Kb/s					

Table 4.5

4.6 GROSS CONFORMANCE TO FCC PART 15 SUBPART F PARG (3) RADIATED EMISSIONS MASK

This test employs a RF spectrum analyzer to measure the radiated emissions of the UWB transceivers. Configure the spectrum analyzer as specified in Table 2.1. Place the spectrum analyzer and antenna at 5 inches from the transmitting UWB transceiver.

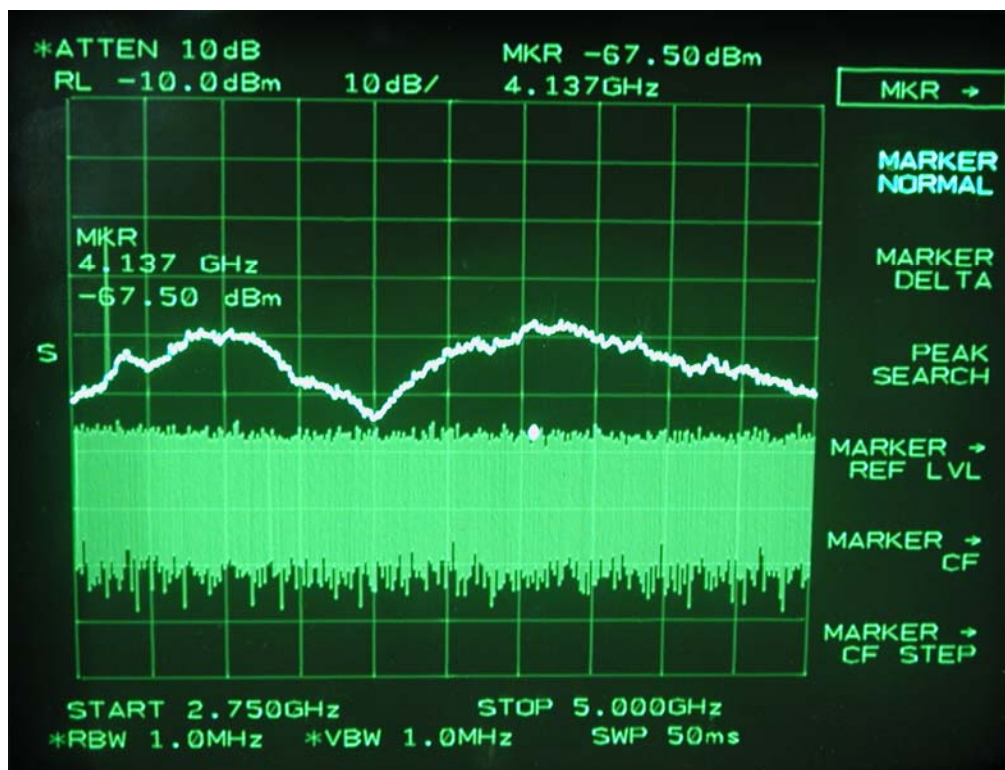
Orient the antenna on the spectrum analyzer for vertical polarization. Configure the data rate of the UWB transceivers as described in section 4.1 per Table 4.6 and repeat test as described in section 4.1 for each data rate and record the composite bandwidth peak emissions as observed on the spectrum analyzer. Repeat this test with the spectrum analyzer's antenna horizontally polarized.

<i>Data Rate (b/s)</i>	<i>Composite Bandwidth Peak Emission (dBuV/m) Vertical Polarization</i>	<i>Composite Bandwidth Peak Emission (dBuV/m) Horizontal Polarization</i>
9.6 M	Unable to test	Unable to test
2.4 M	Unable to test	Unable to test
600 K	Unable to test	Unable to test
150 K	Unable to test	Unable to test
75 K	Unable to test	Unable to test

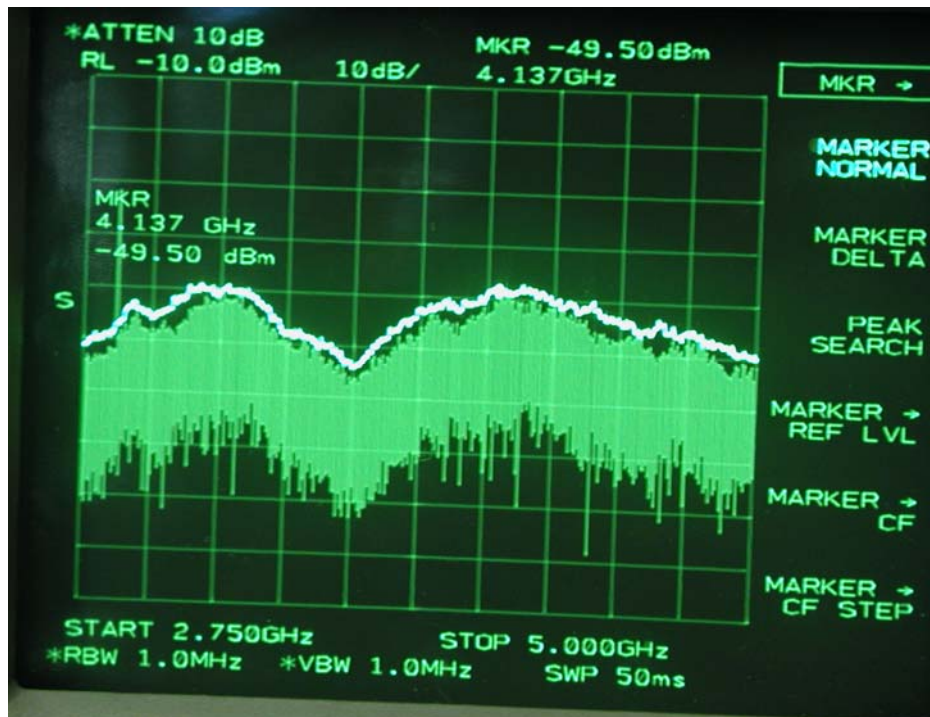
Table 4.6

Despite the inability to detect any UWB emissions at a distance of 5 inches, or greater, it was possible to detect these emissions on a spectrum analyzer through using an external Low Noise Amplifier (LNA) to reduce the effective noise figure of the Spectrum Analyzer. With an external 20 dB LNA with an estimated noise figure of approximately 3 dB attached to a Time Domain Corporation Broadspec® Model P200 sense antenna placed less than 1.5 inches from the UWB transmitter antenna at the input of the spectrum analyzer, it became just within the limits of the test setup to detect UWB emissions above the noise floor of the LNA/Spectrum Analyzer combination through using a slow-enough, narrowband sweep.

The results of measuring these UWB emissions are shown next. The first photograph shows the sensitivity of the noise floor of the LNA and Spectrum Analyzer combination to be -67.5 dBm in a resolution bandwidth of 1 MHz and a video bandwidth of 1 MHz over 2.75 GHz to 5.0 GHz. (This photograph was taken with a max hold of the UWB transmitted spectrum overlaid over the observed noise floor limitation of the test setup.)



Likewise, as seen in the next photograph, the actual UWB transmission has a peak emission level of -49.5 dBm at a frequency of 4.137 GHz, as observed with a max hold reading of the emissions in a resolution bandwidth of 1 MHz and a video bandwidth of 1 MHz. There is also spectral occupancy over a frequency range exceeding the endpoints shown of 2.75 GHz to 5.0 GHz shown here. Unfortunately, with the specific spectrum analyzer used, increasing its sweep range to wider than 2.75 GHz to 5.0 GHz caused an internal band switching to occur, such that the spectrum analyzer noise figure was increased, thereby entirely masking the UWB emissions.



In short, the emissions from the Time Domain UWB EVK were nearly undetectable by any traditional means used for measuring narrowband radio emissions, and were well under the noise floor of an LNA-augmented microwave Spectrum Analyzer at any sense antenna distance greater than 1.5 inches from the UWB transmitter antenna. Because of this, these UWB emissions pose no threat to any communication systems utilizing high signal to noise ratios, being very low-powered and noise-like themselves. The only communication systems that might be detrimentally degraded are those that operate at the very lowest signal to noise ratios, such as GPS, which is a spread spectrum system occupying approximately 20 MHz of bandwidth at link margins of only 1 or 2 dB. Through protection of just those frequency bands where such low SNR systems operate, UWB emissions should cause no problems for the vast majority of locations.

On the other hand, this detection difficulty points out the need for developing alternative ways to detect such emissions, from typical parking lot drive-by spectrum surveillance sweep distances, through developing methods capable of detecting covert or otherwise

illicit UWB transmissions. Otherwise, when IEEE 802.15.3a transmissions become standardized and UWB transmissions become commonplace, it will not be possible to manage the usage of unapproved UWB consumer products short of searching within 1.5 inches of every location where such equipment may be cached.

Volume III of this report contains a discussion of a New Technology Report technique developed on this project for detecting non-cooperative UWB transmissions, to overcome the detection shortcomings identified herein.

5.0 **TEST COMPLETION**

At the completion of all testing: Return this document and all test data to the Project Leader as noted on Page 1.

6.0 **ACRONYMS**

b/s	Bits per second
dB	Decibel
Eb	Energy per bit
FM	Frequency Modulation
ft	Feet
GPS	Global Position System
Kb/s	Kilobits per second
Mb/s	Megabits per second
Neff	Effective noise floor
RF	Radio Frequency
Rx	Receiver or Received
TX	Transmitter or Transmitted
UWB	Ultra Wide Band
VGA	Variable Gain Amplifier
VHF	Very High Frequency
Wi-Fi	Wireless Fidelity

APPENDIX E FSO TEST PLAN

Version: 0.1

Issued By: Range Group

Approved By: _____

Date: 03 April 2003

Project Lead

USTDC Group Manager

USTDC Department Director

NASA Project Manager

Table Of Contents

**(Individual Table of Contents had to be removed to avoid conflicts with
Volume 2's overall Table of Contents)**

1.0 INTRODUCTION

1.1 INTENDED READERSHIP

The audience for this test plan includes, but is not restricted to, the following personnel:

- USTDC staff responsible for performing FSO testing
- USTDC management responsible for FSO testing supervision
- NASA management responsible for FSO testing oversight
- Communication Engineers at NASA KSC interested in FSO technology for possible future use at KSC
- Communication Engineers and Policy Makers throughout NASA interested in FSO technology

1.2 DOCUMENT APPLICABILITY

This test plan applies to the of AirFiber 5800-0622-MM OTU available from AirFiber Corporation of San Diego, California.

1.3 DOCUMENT PURPOSE

This test plan is a guide to the evaluation tests to be conducted with the AirFiber 5800 equipment from AirFiber Corporation. It outlines the types of tests to be carried out, identifies the features to be tested, and establishes pass and fail criteria.

1.4 HOW TO USE THIS DOCUMENT

This plan is to be used by those responsible for testing, and by those responsible for approving the tests, to ensure that all features that need to be tested are subjected to tests, in accordance with the requirements established in the task order documentation. This test plan should be regarded as being a guide to the test plan phase of the task order, rather than as being a detailed test procedure. A separate document will contain the detailed test procedures.

1.5 REFERENCE DOCUMENTS

This test plan is a part of the FY03 Emerging Communication Technology (ECT) task order. This task orders should be read and considered while evaluating this test plan, to guarantee that all requirements are met. The other major associated document files are the AirFiber Corporation documentation, available on the CD provided with the equipment and additional documentation available as a download from the AirFiber web site. Together, these documents should be used to evaluate this test plan. The full list of applicable documents is as follows:

- [1] Engineering Development Contract Task Order, Reference: 6CRG331; Emerging Communications Technology (ECT)
- [2] AirFiber 5800, Element Management System User Guide (P/N 700-0155-000), AirFiber Corporation, San Diego, CA
- [3] AirFiber 5800 System Description Guide (P/N 700-0162-000), AirFiber Corporation, San Diego, CA
- [4] AirFiber 5800 Camera Link-Acquisition User Guide (P/N 700-0163-000), AirFiber Corporation, San Diego, CA
- [5] AirFiber 5800 Produce Information (P/N 700-0168-000), AirFiber Corporation, San Diego, CA
- [6] FSO Test Procedure (ECT-T-002)

1.6 CONVENTIONS

There are no unusual stylistic and command syntax conventions used in communicating with the interfaces of the FSO equipment. Interfaces are SC (fiber), USB port, and RJ-45

1.7 OVERVIEW

This test plan covers performance and feature testing of the AirFiber 5800 hardware, software, and user interfaces. Its purpose is to evaluate if the AirFiber equipment meets key requirements necessary for future incorporation of FSO technology at KSC.

1.8 SCOPE

FSO testing will be limited as follows:

1.8.1 Test Items

Testing will be limited to one pair of AirFiber 5800 OTUs.

1.8.2 Test Purpose

This plan covers only the initial evaluation of the AirFiber hardware and software; it does not address acceptance testing.

1.8.3 Test Locations

Testing locations will normally be limited to one laboratory and up to three outdoors locations within KSC and CCAFS. Other areas may be considered if they offer an advantage.

1.8.4 Attenuation

Attenuation tests will generally be limited to distance and weather effects. Weather effects will be limited to available weather in the test locations.

1.8.5 Surface Heating Effects

Surface heating effects will be evaluated using two or more typical KSC surfaces (asphalt, water, grass, sand, or concrete)

1.8.6 Interference

Interference effects will be evaluated using one or more COTS laser pointers.

2.0 **TEST PLAN**

Free Space Optics (FSO) is an emerging communication technology that holds great promise for the fast installation of communication links, both voice and/or data, at high data rates over short distances. FSO offers the equivalence of fiber transmission rates without the expense of in-ground installation. In addition, FSO offers the ability to have a wireless/fiberless connection in mobile or extreme environments where physical contact can present engineering challenges. The communication capabilities inherent with FSO equipment are likely to be of great benefit to business, public safety, consumer applications, and Government needs for varied tasks ranging from high data rate communications to mobile transport LAN links. Because of this widespread benefit, it is necessary to assess the inherent capabilities of FSO technology for direct use at KSC.

Since FSO is susceptible to attenuation due to weather and distances, and may be influenced by surface heating effects, detailed testing is needed to measure technical parameters and to assess Range usefulness.

The goal of this test plan is to address these key concerns in both a quantitative and qualitative fashion, and to assess whether FSO communication systems are practically for unique Range communication systems. Additionally, the capability of FSO communication equipment to transport Ethernet data must be investigated to assess the robustness of FSO communication signals. This test plan identifies the tests to accomplish these goals.

2.1 **OBJECTIVES**

The testing objectives are as follows:

- Evaluate COTS FSO equipment for possible future use at KSC
- Identify any fundamental shortcomings that must be filled in commercial FSO communication technologies prior to integrating functions into an integrated future data
- Verify the Functionality of the AirFiber 5800 equipment

2.2 **TEST RESOURCES**

2.2.1 **Test Items**

Test items are as follows:

- AirFiber 5800 software, latest version
- AirFiber CAMLAB software, version 1.02, 2000
- AirFiber 5800 hardware, consisting of:
 - ◆ Two 5800-0623-MM Transceivers
 - ◆ Ancillary equipment including power supplies and mounts

2.2.2 Test Facilities

Initial test facilities include the following:

- Advanced Network Development Lab (EDL Bld, Rm 124)
- EDL parking lot
- NASA Causeway East
- Shuttle Landing Facility (if available)

2.2.3 Test Equipment

Initial test equipments include the following:

- SmartBits 2000 with appropriate plug-ins
- Acterna ANT-20

Other test equipment may be utilized as need and when appropriate.

2.2.4 Support Organizations

The following support organizations may be utilized:

- Shuttle Landing Facility (permission & support to used facility)

2.3 **FEATURES TO BE TESTED**

The test plan assumes that the following features of the FSO are to be tested:

2.3.1 Hardware Functionality

Testing will evaluate if major features of the hardware operate within pre-determined parameters.

2.3.2 Software Functionality

During testing, software will be evaluated to see if it works as intended, without glitches and lock-ups.

2.3.3 Conformance

Testing will determine if interfaces and data transfer rates (OC-3 & OC-12) conform to current industry standards.

2.3.4 Interoperability

System testing within a network will determine if the FSO equipment operates as expected.

2.3.5 Throughput Performance

Performance testing will measure BER and latency as a function of:

- Data rate
- Range
- Weather
- Surface Heating Effects

- Interference

2.4 FEATURES NOT TO BE TESTED

2.4.1 Safety

Operational safety testing is not a part of this test plan. The AirFiber 5800 is UL approved and the laser is rated as an eye safe Class 1M device. If any unsafe conditions are identified during routine testing, they will be noted in the marked-up Test Procedures and discussed in the Final Report.

2.4.2 Security

Data security is not a part of this test plan. The hardware does contain intrusion alarms and these will be evaluated.

2.4.3 Portability

Portability testing will not a part of this test plan. Although testing will require transporting the FSO equipment to various locations, the AirFiber 5800 is not designed to be portable or easily transportable.

2.4.4 Environmental Requirements

Environmental exposure testing is not a part of this test plan. Environmental (weather) effects on FSO performance are a part of the test plan. The ability of the equipment to handle a coastal environment is not a specific test parameter; however, if equipment degradation is observed, it will be noted in the marked-up Test Procedures and discussed in the final report. Subsequent testing of operational units under environmental extremes may be recommended.

2.4.5 Long-term Reliability

It will ultimately become a requirement that fielded systems must show an acceptably low number of failures of the software and hardware averaged over a significant period. This can only be tested in regular and extended use of the equipment, and so shall not form part of the test plan for this task, which concentrates on fundamental feasibility and applicability of the technology and not of a particular implementation.

2.5 APPROACH

Tests will be performed in accordance with the requirements identified in this Test Plan. Significant problems encountered during testing will be recorded for documenting any failures or problems, even where these problems are agreed as non-critical.

1.1.1 Detailed Test Configurations

Performance testing will utilize the following configuration:

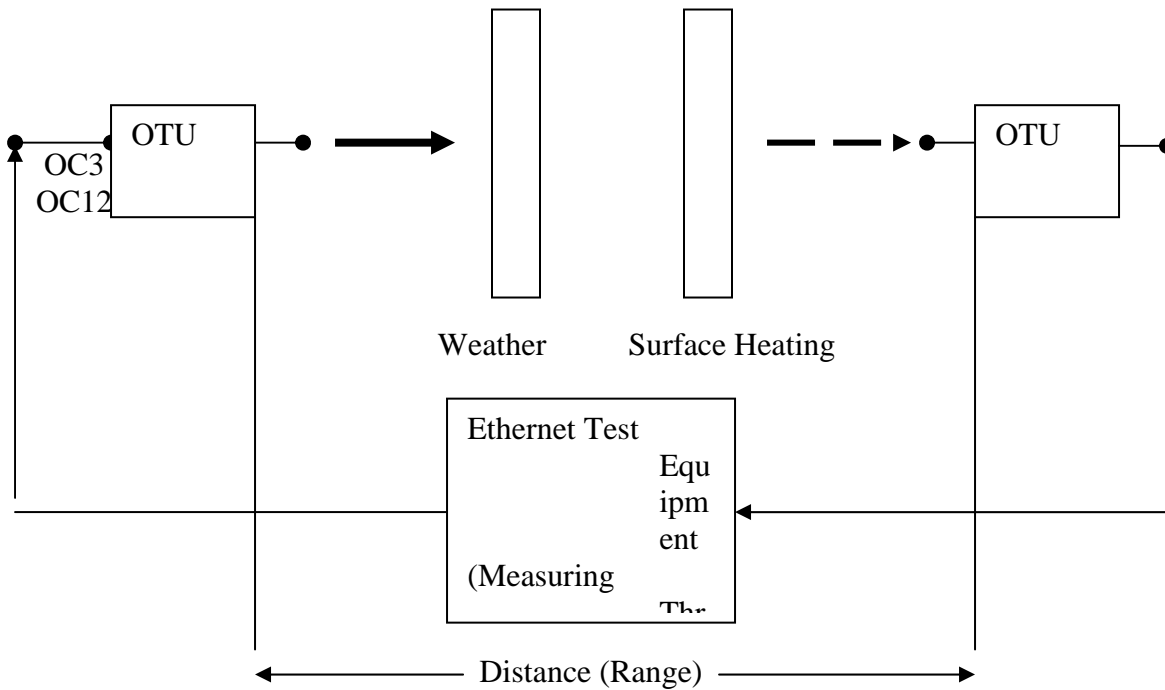


Figure 2.5-1
FSO Test Configuration

1.1.2 Test Parameters

Testing parameters will include the following:

- Hardware functionality – Evaluate following features:
 - ◆ Door interlocks
 - ◆ Time to acquire link with mating OTU
 - ◆ Capability to loop back data
 - ◆ Camera control
- Software functionality – Secondary result of all testing
- Conformance – Verify operational with OC-3 & OC-12 data rates
- Operation – Secondary result of all testing

- Interoperability – Test within a SONET network
- Throughput performance – Per following test parameters and table:
 - ◆ Independent Variables
 - Distance (35' to 3000')
 - Weather (clear, rain, fog)
 - Data Rates (OC-3 & OC-12)
 - Surface Effects (Asphalt, water, grass, concrete)
 - ◆ Dependent variables
 - Performance (BER & Latency)

Table 2.4.1 FSO Test Plan Configurations

Tests	Data Rate	Range (ft.)	Weather	Surface Effect	Measured Parameters	Comments
Performance as a function of: <ul style="list-style-type: none"> • Data Rate • Range 	OC-3 OC-12	35, 100, 500, 1000, 2000, 3000	Clear	As available	BER & Latency	Indoor lab environment for short distances; outside for longer distances. Range measured between the two transceivers.
Performance as function of: <ul style="list-style-type: none"> • Data Rate • Range • Weather 	OC-3 OC-12	500, 1000, 3000	Rain & Fog - as available	As available	BER & Latency	Outside mobile testing for all distances
Performance as function of: <ul style="list-style-type: none"> • Data Rate • Range • Surface 	OC-3 OC-12	500, 1000, 3000	Clear	Asphalt, grass, water, concrete	BER & Latency	Outside mobile testing for all distances
Interference	OC-3 OC-12	35, 100, 200	Clear	As available	BER	Using laser pointer

2.6 PASS/FAIL CRITERIA

Different features of the FSO will have different pass/fail criteria according to the requirements that must be satisfied. The FSO will be judged to have passed user interface criteria if no critical problems that relate to the test have occurred. The criteria for criticality are as follows:

- Critical failures include crash, incorrect results, and unsafe behavior
- Non-critical failures will include any failure to meet a non-essential requirement

2.6.1 Hardware Functionality

This should be demonstrated using the test procedures in Reference [6].

2.6.2 Software Functionality

This should be demonstrated using the test procedures in Reference [6], based upon pass/fail on simple functionality tests, i.e. does the item (do the items) perform the basic functionality that is required?

2.6.3 Conformance

Conformance will be judged to pass or fail based on the ability of the AirFiber 5800 FSO link to operate in a steady and reliable configuration at both OC-3 and OC-12 data rates.

2.6.4 Interoperability

Communication with other network equipment will be demonstrated by the test procedures in Reference [6], based upon pass/fail on simple functionality tests.

2.6.5 Performance

Performance acceptance criteria will be identified in the test procedures in Reference [6].

2.7 SUSPENSION CRITERIA AND RESUMPTION REQUIREMENTS

Any test should be suspended in the event of failure to meet the requirement, or in the event of causing untoward interference with licensed radio services. A suspended test should only be resumed if project lead and appropriate management can agree on either

- A course of action to remedy the problem, or
- The relaxation of a requirement to allow testing to continue has no implication for the overall performance of the system, or

if none of the above is possible, the test will be deemed to have failed, and the testing should progress to the next test if this is possible given the previous failure(s).

2.8 TEST DELIVERABLES

2.8.1 Prior to testing

Before testing starts, the project lead will ensure that the following items are made available to all members of the test team:

- Test Plan
- Test Procedures

The following items will be available for reference in the laboratory:

- FSO Documentation provided by AirFiber Corporation
- FSO release software

2.8.2 After Testing

When testing ends, the following data items will be generated and made available as a part of testing:

- Test Procedure results

No post-test processing is anticipated.

Testing results, analysis, conclusions and recommendations will be the main topics of the ECT Final Report.

2.9 TEST TASKS

In preparation for carrying out the tests, it will be necessary to ensure that the full FSO system is operational. Since the OTUs are programmed via laptops, suitable cables must be in place. An optical OC-3 / OC-12 data source and suitable test equipment will also be necessary.

2.10 ENVIRONMENTAL NEEDS

Testing will be conducted initially in a lab conditions. Subsequent testing is planned in more demanding outside weather, as conditions permit.

2.11 RISKS AND CONTINGENCIES

The tight time schedule for all work and the fact that special weather conditions should be evaluated represent a risk to FSO testing. Since weather is beyond anyone's control, the test procedures will be adjusted as necessary to investigate weather opportunities.

2.12 APPROVALS

This plan is to be reviewed as it develops through the initial test phases of the task order, and, following review, is to be submitted for approval by the NASA Project Manager.

3.0 **GLOSSARY**

The following acronyms and abbreviations are used in this document:

ASRC	Artic Slope Regional Corporation
APD	Avalanche Photodetector Diode, a type of optical detector more sensitive than a PIN diode, requiring relative high dc voltage bias (~100 Vdc) for proper operation
BER	Bit error rate
CCAFS	Cape Canaveral Air Force Station
COTS	Commercial Off The Shelf
ECT	Emerging Communication Technology
EDL	Engineering Development Laboratory
FY	Fiscal Year (Oct 1 – Sept 30)
FSO	Free Space Optics; Free Space Optical
IEEE	Institute of Electrical & Electronic Engineers
KSC	Kennedy Space Center
LAN	Local Area Network
Latency	Time for one-way travel from sender to receiver
Mbps	Million Bits Per Second, often called megabits per second
ms	millisecond (1×10^{-3} seconds; a thousandth of a second)
ns	nanosecond (1×10^{-9} seconds, a billionth of a second)
OC-3	Optical Carrier transport at 155 Mbps
OC-12	Optical Carrier transport at 622 Mbps
OE	Optical to Electrical conversion
OEO	Optical to Electrical to Optical conversion
OTU	Optical Transceiver Unit
PIN	Positive-Intrinsic-Negative, a type of photodiode
ps	picosecond (1×10^{-12} seconds, one thousandth of a billionth of a second)
TIA	Trans-Impedance Amplifier, a current to voltage converting amplifier used for converting the detected photodetector current to a voltage for receiving an optical signal within the PHY (physical) layer of an FSO link
USTDC	University-affiliated Spaceport Technology Development Contract
μ s	microsecond (1×10^{-6} seconds), one millionth of a second
Xcvr	Transceiver

APPENDIX F FSO TEST PROCEDURE

Version: 0.1

Issued By: Range Group

Approved By: _____

Date:

Project Lead

EDC Group Manager

EDC Department Director

NASA Project Manager

Table Of Content

**(Individual Table of Contents had to be removed to avoid conflicts with
Volume 2's overall Table of Contents)**

1.0 INTRODUCTION

1.1 BACKGROUND

This test procedure is a part of the FY03 Emerging Communication Technology (ECT) task order. This task involves evaluating three evolving communication technologies for possible use on the Range. This series of test procedures will be evaluating the following Free Space Optic (FSO) equipment:

- AirFiber 5800 software, latest version
- AirFiber CAMLAB software, version 1.02, 2000
- AirFiber 5800 hardware, comprising:
 - ◆ Two 5800-0623-MM Transceivers
 - ◆ Ancillary equipment including power supplies and mounts

1.2 SCOPE

Testing will be limited to two AirFiber 5800 OTUs shown above and to evaluating the following:

- Functionality
- Performance due to following
 - ◆ Data rate
 - ◆ Range
 - ◆ Weather effects
 - ◆ Surface heating effects
 - ◆ Interference

1.3

REFERENCES

- ◆ FSO Test Plan (ECT-T-001)
- ◆ Engineering Development Contract Task Order, Reference: 6CRG331; Emerging Communications Technology (ECT)
- ◆ Gateway DS 450 X embedded help software
- ◆ AirFiber 5800, Element Management System User Guide (P/N 700-0155-000), AirFiber Corporation, San Diego, CA
- ◆ AirFiber 5800 Camera Link-Acquisition User Guide (P/N 700-0163-000), AirFiber Corporation, San Diego, CA

2.0 GENERAL TEST PROCEDURES

2.1 PERSONNEL

The test team will consist of all or part of the following personnel:

- Test coordinator – leader of test activities
- Test assistant(s) – assist the test coordinator in functions requiring more than one person.
- Test witness(es) – witness key parts of the test

2.2 SCHEDULE

The test schedule is as follows:

TBD

2.3 TEST RESOURCES

2.3.1 Test Items

Test items are as follows:

- AirFiber 5800 OUT and ancillary equipment
- Gateway DS 450 X laptop computer
- Gateway 450 SX4 User Guide, 10/20/2002

2.3.2

Test Facilities

Test facilities include the following:

- Advanced Network Development Lab (EDL Bld, Rm 124)
- EDL Building

2.3.3 Test Equipment

Test equipment may include the following:

- SmartBits 2000 with appropriate plug-ins
- Acterna ANT-20

Other test equipment may be utilized as need and when appropriate.

2.3.4 Support Organizations

The following support organizations may be utilized in setting up for the test:

- Shuttle Landing Facility (permission & support to use facility)

2.4 **RESULTS**

2.4.1 Background Data

The following Background Data shall be recorded for all tests:

- Date
- Time
- Location
- Test Coordinator
- Test Personnel
- Hardware
- Test Equipment
- Calibration Dates

2.4.2 Test Data

Test Data shall be recorded on the sheets provided in Section 3 or other suitable forms.

2.4.3 Anomalies

All anomalies witnessed during checkout, set-up or testing shall be recorded and described in the comments section of the Data Sheet or on another suitable form. The full description should include, as a minimum, the following:

- Test configuration
- Test hardware being used
- Test equipment and calibration date
- Sub-test or operation being attempted
- Indication of anomaly
- Test conductor

- Test witnesses
- Date
- Time of day

2.4.4 Safety

Any product safety issues that appear during checkout, set-up or testing shall be documented in the comments section of the Data Sheet or within another suitable document. The issue and supporting data shall be described in full detail sufficient for someone else to repeat the observation.

3.0 **DETAILED TEST PROCEDURES**

Testing procedures and Data Sheets are included in the following sections.

Computers refer to the two ECT Laptop computer purchased for the project as follows:

Keeper	MAC #
BH - Bill Harris	00-02-2D-6E-A2-F4
GB – Gary Bastin	00-02-2D-6E-5B-7E

OTUs refer to the two AirFiber 5800 transceivers identified as follows:

Title	Floor	Room	Factory IP	Current IP	Loc
Tower1	1	124	10.0.0.1	128.217.107.176	Bench
Tower2	1	124	10.0.0.2	128.217.107.177	Cabinet

3.1 TEST 1: SET-UP, FUNCTIONALITY & INTEROPERABILITY

Objective: Test the set-up procedures, functionality, and interoperability for the AirFiber 5800 OTU

1. Set up and initialize both AirFiber 5800 OTUs in the EDL Advanced Network Development Lab
2. Confirm successful operation, documenting any anomalies
3. Measure Transmit laser power
4. Measure Receive power for each location
5. Run SmartBits Throughput and Packet Loss tests
6. Repeat above to obtain additional data points

3.2 TEST 2: RELIABILITY & WEATHER EFFECTS

OBJECTIVE: Test the set-up procedures, functionality, and interoperability for the AirFiber 5800 OTU outdoors in various types of weather.

1. Set up and initialize both AirFiber 5800 OTUs on the EDL Roof
2. Confirm successful operation, documenting any anomalies
3. Measure Transmit laser power
4. Measure Receive power for each location
5. Run SmartBits Throughput and Packet Loss tests
6. Repeat above in various types of weather

3.3 TEST 3: REMOTE TESTING

OBJECTIVE: Test the set-up procedures, functionality, and interoperability for the AirFiber 5800 OTU outdoors in a remote environment.

1. Set up and initialize both AirFiber 5800 OTUs in the EDL parking lot
2. Confirm successful operation, documenting any anomalies
3. Measure Transmit laser power
4. Measure Receive power for each location
5. Run SmartBits Throughput and Packet Loss tests
6. Repeat above in various types of weather

3.4 TEST 4: MEDIUM DISTANCE TESTING

OBJECTIVE: Test the set-up procedures, functionality, and interoperability for the AirFiber 5800 OTU outdoors in a remote environment at medium distances.

1. Set up and initialize both AirFiber 5800 OTUs. Place one unit in the EDL parking lot and the other unit at a medium distance.
2. Confirm successful operation, documenting any anomalies
3. Measure Transmit laser power
4. Measure Receive power for each location
5. Run SmartBits Throughput and Packet Loss tests
6. Repeat above in various types of weather

4.0 **GLOSSARY**

The following acronyms and abbreviations are used in this document:

BER	Bit error rate
CCAFS	Cape Canaveral Air Force Station
COTS	Commercial off the Shelf
ECT	Emerging Communication Technology
EDL	Engineering Development Laboratory
FY	Fiscal Year (Oct-Sept)
IEEE	Institute of Electrical & Electronic Engineers
KSC	Kennedy Space Center
LAN	Local Area Network
Mbps	Million Bits per Second
OC-3	155 Mbps
OC-12	622 Mbps
OTU	Optical Transceiver Unit
SNR	Signal to Noise Ratio
TRR	Test Readiness Review
W	Watts
WEP	Encryption code key (26 characters = 128 bit encryption)
Wi-Fi	Wireless Ethernet
WWW	World Wide Web
Xcvr	Transceiver

APPENDIX G FSO TEST RESULTS**1.0 TEST 1: SIGNAL STRENGTH**

FSO Test Data													
Date	Time	Az	El	Output TxP uW	Range Ft	Local RxP mV	Remote RxP mV	T °F	Loc	Wx	Local Input Twr	Loop Back	Comments
1/15/03	900	-	-	2000	28	-	-	75	ANDL	Indoors	1	N	Factory install
4/3/03	1000	-	-	2000	28	-	2546	75	ANDL	Indoors	2	Y	
4/3/03	1030	-	-	2000	28	2838	2457	75	ANDL	Indoors	2	Y	
4/3/03	1035	-	-	2000	28	2800	-	75	ANDL	Indoors	2	Y	
4/3/03	1036	-	-	2000	28	2800	2571	75	ANDL	Indoors	2	Y	
4/3/03	1037	-	-	2000	28	2741	2572	75	ANDL	Indoors	2	Y	
4/3/03	1038	-	-	2000	28	2767	2559	75	ANDL	Indoors	2	Y	
4/3/03	1039	-	-	2000	28	2950	2556	75	ANDL	Indoors	2	Y	
4/3/03	1040	-	-	2000	28	2641	2556	75	ANDL	Indoors	2	Y	
4/3/03	1041	-	-	2000	28	2647	2556	75	ANDL	Indoors	2	Y	
4/3/03	1042	-	-	2000	28	2732	2556	75	ANDL	Indoors	2	Y	
4/3/03	1043	-	-	2000	28	2680	2565	75	ANDL	Indoors	2	Y	
4/3/03	1044	-	-	2000	28	2687	2574	75	ANDL	Indoors	2	Y	
4/3/03	1103	-	-	2500	28	-	-	75	ANDL	Indoors	2	Y	2 screens on tower 1
4/3/03	1030	-	-	2500	28	-	-	75	ANDL	Indoors	2	Y	2 screens on tower 1
4/3/03	1035	-	-	-	28	2408	2093	75	ANDL	Indoors	2	Y	2 screens on tower 1
4/3/03	1036	-	-	-	28	2390	2093	75	ANDL	Indoors	2	Y	2 screens on tower 1
4/3/03	1037	-	-	2500	28	2275	2093	75	ANDL	Indoors	2	Y	2 screens on tower 1
4/3/03	1038	-	-	2500	28	-	2093	75	ANDL	Indoors	2	Y	2 screens on tower 1
4/3/03	1039	-	-	2500	28	2381	2093	75	ANDL	Indoors	2	Y	2 screens on tower 1
5/9/03	900	-	-	-	300	-	-	80	ANDL	Clear	2	Y	Roof Link established
5/12/03	830	1622	-1402	2000	300	4399	3867	80	Roof	Clear	2	Y	EDL roof
5/21/03	900	1622	-1419	2000	300	4390	3808	80	Roof	Clear	2	Y	
5/29/03	1600	1614	-1410	2000	300	4452	3956	90	Roof	Clear	2	Y	
5/30/03	1340	1613	-1410	2000	300	4461	3860	90	Roof	Cloudy	2	Y	
6/2/03	1400	1615	-1408	2000	300	3892	3783	90	Roof	Cloudy	2	Y	
6/4/03	1310	1619	-1412	2000	300	4447	3860	90	Roof	Cloudy	2	Y	
6/5/03	1056	1620	-1407	2000	300	4438	3851	85	Roof	Cloudy	2	Y	
6/9/03	1338	1617	-1423	2000	300	3856	3112	85	Roof	Rain	2	Y	
6/9/03	1343	1617	-1423	2000	300	4026	2898	85	Roof	Rain	2	Y	
6/9/03	1345	1617	-1423	2000	300	3922	2772	85	Roof	Rain	2	Y	
6/9/03	1347	1617	-1400	2000	300	2936	2253	80	Roof	Hv rain	2	Y	
6/9/03	1350	1620	-1406	2000	300	2936	3159	80	Roof	Hv rain	2	Y	
6/9/03	1352	1620	-1414	2000	300	3849	3486	80	Roof	Lt rain	2	Y	
6/9/03	1355	1620	-1414	2000	300	4208	3594	80	Roof	Lt rain	2	Y	
6/9/03	1359	1620	-1414	2000	300	4003	3463	80	Roof	Lt rain	2	Y	
6/9/03	1400	1620	-1414	2000	300	4003	3417	80	Roof	Lt rain	2	Y	
6/9/03	1402	1620	-1414	2000	300	3746	3134	80	Roof	Med rain	2	Y	
6/9/03	1404	1620	-1414	2000	300	3505	3189	80	Roof	Med rain	2	Y	
6/9/03	1406	1620	-1414	2000	300	3403	3189	80	Roof	Med rain	2	Y	
6/9/03	1407	1620	-1414	2000	300	4015	2845	80	Roof	Lt rain	2	Y	
6/9/03	1411	1622	-1411	2000	300	4073	3368	80	Roof	Lt rain	2	Y	
6/10/03	711	1622	-1415	2000	300	4305	3582	75	Roof	Lt fog	2	Y	
6/10/03	715	1620	-1406	2000	300	4379	3676	75	Roof	Lt fog	2	Y	
6/10/03	721	1622	-1415	2000	300	4351	3644	75	Roof	Lt fog	2	Y	

ECT Phase 2 – Vol. 2 – Appendices

Date	Time	Az	El	Output TxP uW	Range Ft	Local RxP mV	Remote RxP mV	T °F	Loc	Wx	Local Input Twr	Loop Back	Comments
6/11/03	1352	1620	-1404	2000	300	4508	3863	90	Roof	Clear	2	Y	
6/12/03	1308	1619	-1402	2000	300	4485	3640	90	Roof	Clear	2	Y	
6/12/03	1312	1619	-1402	2000	300	4527	3649	90	Roof	Clear	2	Y	
6/12/03	1316	1618	-1406	2000	300	4520	3923	90	Roof	Clear	2	Y	
6/13/03	1335	1619	-1405	2000	300	4532	3916	85	Roof	Clear	2	Y	
6/13/03	1336	1619	-1405	2000	300	4535	3859	85	Roof	Clear	2	Y	
6/13/03	1340	1619	-1416	2000	300	4532	3785	85	Roof	Clear	2	Y	
6/16/03	1002	1612	-1408	2000	300	3923	3867	75	Roof	Clear	2	Y	
6/17/03	1233	1621	-1401	2000	300	4532	3869	85	Roof	Cloudy	2	Y	
6/17/03	1234	1621	-1401	2000	300	4536	3851	85	Roof	Cloudy	2	Y	
6/17/03	1235	1621	-1401	2000	300	4534	3847	85	Roof	Cloudy	2	Y	
6/18/03	717	1618	-1411	2000	300	4437	3743	75	Roof	Clear	2	Y	
6/18/03	721	1618	-1411	2000	300	4494	3783	75	Roof	Clear	2	Y	
6/20/03	1453	1622	-1409	2000	300	4036	2790	85	Roof	Lt rain	2	Y	
6/20/03	1455	1622	-1411	2000	300	4036	2960	85	Roof	Lt rain	2	Y	
6/20/03	1456	1618	-1412	2000	300	4036	2488	85	Roof	Lt rain	2	Y	
6/20/03	1457	1618	-1419	2000	300	3567	2839	85	Roof	Lt rain	2	Y	
6/20/03	1459	1618	-1419	2000	300	3302	2651	85	Roof	Lt rain	2	Y	
6/23/03	1427	1620	-1414	2000	300	4544	3886	80	Roof	Clear	2	Y	
6/23/03	1428	1620	-1414	2000	300	4544	3870	80	Roof	Clear	2	Y	
6/24/03	818	1619	-1405	2000	300	4546	3807	80	Roof	Clear	2	Y	
6/24/03	823	1619	-1406	2000	300	4544	3822	80	Roof	Clear	2	Y	
6/24/03	825	1619	-1406	2000	300	4546	3812	80	Roof	Clear	2	Y	
6/27/03	711	1616	-1418	2000	300	4040	3887	75	Roof	Clear	2	Y	
6/27/03	712	1616	-1414	2000	300	4546	3862	75	Roof	Clear	2	Y	
6/27/03	718	1616	-1414	2000	300	4543	3854	75	Roof	Clear	2	Y	
6/27/03	720	1616	-1416	2000	300	4543	3829	75	Roof	Clear	2	Y	
6/27/03	723	1616	-1416	2000	300	4546	3840	75	Roof	Clear	2	Y	
6/27/03	726	1616	-1416	2000	300	4546	3819	75	Roof	Clear	2	Y	
6/27/03	1346	1615	-1407	2000	300	4546	3947	80	Roof	P cloudy	2	Y	
6/27/03	1350	1616	-1410	2000	300	4546	3711	80	Roof	P cloudy	2	Y	
6/30/03	946	1615	-1397	2000	300	4546	3862	85	Roof	clear	2	Y	
6/30/03	948	1615	-1402	2000	300	4544	3784	85	Roof	clear	2	Y	
6/30/03	951	1616	-1402	2000	300	4194	3791	85	Roof	clear	2	Y	
7/2/03	1425	1615	-1411	2000	300	4506	3873	90	Roof	Clear	2	Y	
7/2/03	1427	1615	-1411	2000	300	4546	3873	90	Roof	Clear	2	Y	
7/2/03	1429	1615	-1411	2000	300	4546	3853	90	Roof	Clear	2	Y	
7/3/03	717	1616	-1417	2000	300	4546	3750	75	Roof	Clear	2	Y	
7/3/03	721	1616	-1417	2000	300	4366	3753	75	Roof	Clear	2	Y	
7/15/03	1400	1609	-1422	2000	300	4540	3793	80	Roof	Lt rain	2	Y	
7/15/03	1402	1609	-1422	2000	300	4546	3702	80	Roof	Lt rain	2	Y	
7/15/03	1408	1608	-1423	2000	300	3815	3055	80	Roof	Med rain	2	Y	
7/15/03	1409	1608	-1423	2000	300	4001	2935	80	Roof	Med rain	2	Y	
7/15/03	1414	1608	-1423	2000	300	3729	3195	80	Roof	Med rain	2	Y	
7/15/03	1421	1608	-1423	2000	300	4322	3283	80	Roof	Med rain	2	Y	
7/15/03	1426	1610	-1419	2000	300	4475	3550	80	Roof	Lt rain	2	Y	
7/17/03	1452	1618	-1411	2000	300	4494	3783	85	Roof	Clear	2	Y	
7/17/03	1453	1611	-1415	2000	300	4315	3764	85	Roof	Clear	2	Y	
7/17/03	1453	1611	-1415	2000	300	4278	3764	85	Roof	Clear	2	Y	
7/21/03	1515	1605	-1416	2000	300	4546	3839	90	Roof	Clear	2	Y	
7/21/03	1517	1605	-1413	2000	300	4546	3839	90	Roof	Clear	2	Y	
7/21/03	1518	1608	-1416	2000	300	4546	3711	90	Roof	Clear	2	Y	
7/21/03	1520	1605	-1416	2000	300	4546	3853	90	Roof	Clear	2	Y	
7/22/03	1510	1609	-1404	2000	300	4546	3835	85	Roof	Lt rain	2	Y	
7/22/03	1512	1610	-1416	2000	300	4546	3773	85	Roof	Lt rain	2	Y	
7/22/03	1514	1610	-1416	2000	300	4546	3781	85	Roof	Lt rain	2	Y	
7/22/03	1515	1610	-1416	2000	300	4546	3813	85	Roof	Lt rain	2	Y	
7/22/03	1516	1610	-1416	2000	300	4546	3802	85	Roof	Lt rain	2	Y	
7/22/03	1524	1610	-1416	2000	300	4546	3631	85	Roof	P cloudy	2	Y	
7/22/03	1525	1610	-1423	2000	300	4546	3554	85	Roof	P cloudy	2	Y	

ECT Phase 2 – Vol. 2 – Appendices

Date	Time	Az	El	Output TxP uW	Range Ft	Local RxP mV	Remote RxP mV	T °F	Loc	Wx	Local Input Twr	Loop Back	Comments
7/31/03	928	-1427	-423	2000	113	4546	3655	85	E Lot	Clear	2	Y	EDL E. parking lot
7/31/03	929	-1404	-423	2000	113	4546	3434	85	E Lot	Clear	2	Y	
7/31/03	931	-1414	-404	2000	113	4546	3347	85	E Lot	Clear	2	Y	
7/31/03	947	-279	-862	2000	113	3781	4546	85	E Lot	Clear	1	Y	
7/31/03	948	-268	-863	2000	113	3781	4546	85	E Lot	Clear	1	Y	
7/31/03	950	-268	-876	2000	113	3781	4546	85	E Lot	Clear	1	Y	
7/31/03	952	-268	-862	2000	113	3635	4546	85	E Lot	Clear	1	Y	
7/31/03	1327	-1361	-390	2000	113	4546	3813	85	E Lot	Clear	2	Y	
7/31/03	1329	-1361	-390	2000	113	4546	3822	85	E Lot	Clear	2	Y	
7/31/03	1330	-1361	-390	2000	113	4546	3761	85	E Lot	Clear	2	Y	
8/4/03	1555	-276	-875	2000	113	3536	4546	85	E Lot	Clear	2	Y	
8/4/03	1556	-276	-874	2000	113	3649	3935	85	E Lot	Clear	2	Y	
8/4/03	1556	-276	-874	2000	113	3665	3935	85	E Lot	Clear	2	Y	
8/4/03	1557	-276	-874	2000	113	3668	3935	85	E Lot	Clear	2	Y	
8/4/03	1602	-1371	-418	2000	113	4543	3630	85	E Lot	Clear	1	Y	Switch input
8/4/03	1603	-1371	-418	2000	113	4544	3668	85	E Lot	Clear	1	Y	
8/4/03	1606	-1371	-418	2000	113	4546	3638	85	E Lot	Clear	1	Y	
8/6/03	646	-1472	-146	9000	1066	4533	3935	75	SSPF	Clear	2	Y	EDL N lot to SSPF
8/6/03	648	-1472	-423	9000	1066	4533	-	75	SSPF	Clear	2	Y	113 ft
8/6/03	657	-1472	-423	9000	1066	4533	-	75	SSPF	Clear	2	Y	
8/6/03	706	-1512	-419	2000	1066	-	-	75	SSPF	Clear	2	Y	
8/6/03	712	-1512	-419	2000	1066	3567	2593	75	SSPF	Clear	2	Y	
8/6/03	722	-2203	-363	2000	1066	2531	3642	80	SSPF	Clear	1	Y	Switch input
8/6/03	735	-2203	-363	2000	1066	2115	3159	80	SSPF	Clear	1	Y	

2.0

TEST 2: THROUGHPUT AND PACKET LOSS**Throughput & Packet Loss tests**

Date	Throughput		Packet Loss		Loc	Loop Back	Comments
	Results	File	Results	File			
4/3/03	100%	Lost	0	Lost	ANDL	Y	Files lost when lab computer was changed
4/3/03	100%	Lost	0	Lost	ANDL	Y	2 screens masks on Twr 1
4/3/03	100%	Lost	0	Lost	ANDL	Y	1000 M of fiber, 2 masks Twr 1
5/9/03	100%	-	0	T-050903-pl.xls	roof	Y	
5/19/03	100%	-	0	T-051905-pl.xls	roof	Y	
6/2/03	100%	-	0	T-060203-pl.xls	roof	Y	
6/27/03	100%	-	0	T-062703-pl.xls	roof	Y	
6/4/03	100%	-	0	T-060403-pl.xls	roof	Y	
6/5/03	100%	T-060503-tp.xls	0	T-060503-pl.xls	roof	Y	
6/27/03	100%	T-062703-tp.xls	0	T-062703-pl.xls	roof	Y	
7/15/03	100%	T-071503-tp.xls	0	T-071503-pl.xls	roof	Y	
7/22/03	100%	T-072203-tp.xls	0	T-072203-pl.xls	roof	Y	
7/31/03	100%	T-073103-tp.xls	0	T-073103-pl.xls	E lot	Y	East EDL parking lot, 113 ft
8/6/03	100%	T-080603-tp.xls	0	T-080603-pl.xls	SSPF	Y	N EDL lot to SSPF lot, 1066 ft

APPENDIX H FSO NOTES

FSO Notes

AirFiber 5800 Operation & Testing

W. G. Harris

8/1/03

Table of Contents

**(Individual Table of Contents had to be removed to avoid conflicts with
Volume 2's overall Table of Contents)**

References

- | | | |
|---|--------------|---|
| 1 | 700-0155-000 | AirFiber 5800 Element Management System; User Guide |
| 2 | 700-0163-000 | AirFiber 5800 Camera Link-Acquisition Program; User Guide |

1.0 GENERAL INFORMATION

The AirFiber 8500 OTUs purchased at KSC in 2002 are reliable high-speed laser COM units. General information is provided below:

Manufacturer	AirFiber 16510 Via Esprillo San Diego, CA 92127
Model	8500 OC-12
Purchase	Pair of AirFiber 8500 OTUs were purchased around 12/12/02 under a program titled Emerging Communication Technology (ECT). This program investigated Laser Com, Wi-Fi, and Ultra Wide Band (USB) technologies.
Cost	The original cost for the 2 OTUs, 2 power boxes and associated equipment was \$23,724.
Installation	By factory personnel on 1/15/03; Units initially installed in the EDL Advanced Network Lab.
Training	Limited training on the OTUs was received by 3 Dynacs (later ASRC) employees (Bill Harris, Dr. Gary Bastin, and Bob Chiodini) in San Diego on 1/21/03.
Bankruptcy	AirFiber closed its doors on 2/26/03
Speed	OC3 or OC12, selectable
Distance	AirFiber 8500s were used to televise the European MTV Awards over a distance of 1.6 km.
Data Format	None; OTUs duplicate any payload data format. A Super Frame is used to transport data and OTU overhead information.

Interfaces	
Voltage	48 V DC from separate power supply enclosure
Power	33 to 222 watts depending on heater usage
Payload In:	Multimode fiber with SC style connector
Payload Out:	Multimode fiber with SC style connector
Cross Link	This option is not available in the KSC units
Management Fiber	The system health may be monitored using a multimode fiber with SC style connectors. The KSC tests did not use this option.
Ethernet	The Ethernet interface through an RJ45 connector is used to monitor the systems health via a Laptop computer. See Section 2 for the process.
Serial	The RS-232 interface is usually not used. It may be used to enter inside the operating system through the backdoor. See Section 2 for the process.
USB – male	The male USB connector is used to receive the camera image on a Laptop using CamLAP.
USB – female	The female USB connector is not used. Its original purpose was to route the image from the USB-male connector into the operating system where it could be monitored via the Ethernet or Management Fiber interfaces. AirFiber never released the next generation operating software with this capability before they closed.
Software	Two different software packages are used with the OTUs
CamLAP	CamLAP is used to view the output from the internal cameras during initial alignment. CamLAP resides within the Laptop computer and is available on a CD. It receives the image data via a USB cable between the OTU and the Laptop. CamLAP also communicates with the OTU operating system via an Ethernet cable from the OTU to the Laptop.
Operating Sys	The VxWorks operating system resides within the OTUs. It is accessed normally via the Ethernet cable using a Web Browser such as Internet Explorer (see Section 2.3). Backdoor entries are also possible as described in Sections 2.4 and 2.5.

2.0 CAMLAP OPERATIONS

2.1 CAMLAP LOGON

S-1	Cables	
S-1.1	<i>Connect</i>	Short USB cable between OTU and Laptop
S-1.2	<i>Connect</i>	Ethernet (RJ45) cable between OTU and Laptop
S-2	<i>Select</i>	Desktop (Icon)
S-3	<i>Open</i>	CamLAP (Icon)
S-4	<i>Enter</i>	Correct IP Tower1 = 128.217.107.176 Tower2 = 128.217.107.177
S-5	OK	
S-6	ERROR	If crosshairs are not visible, the Test Ethernet link between the Laptop and the OTU Service Port is down (Appendix B.1).
S-7	SUCCESSFUL	Crosshairs should be visible in picture. Image should shows peer unit, or in its general direction.
S-8	CABLES	If possible, leave all cables connected for next operations

Process Complete

2.2 CAMLAP LOGOUT

Always logout from CamLAP to prevent locking up the Operating System.

S-1	CABLES	
S-1.1	<i>Verify</i>	Short USB cable between OTU and Laptop
S-1.2	<i>Verify</i>	Test Ethernet cable between OTU and Laptop
S-2	<i>Select</i>	<i>File</i>
S-3	<i>Select</i>	<i>Exit</i>
S-4	SUCCESSFUL	CamLAP page and image disappear
S-5	CABLES	
S-5.1	<i>Disconnect</i>	Short USB cable between OTU and Laptop
S-5.2	<i>Disconnect</i>	Test Ethernet cable between OTU and Laptop
S-5.3	<i>Connect</i>	Service Ethernet cable between OTU and Laptop

Process Complete

2.3 OTU INITIALIZATION

When OTUs are relocated or installed for the first time, they have to be “Initialized”.

S-1	Verify	Both Replacement OTUs have their Commissioned flags set to False before initializing (Section 3.6)
S-1.1	<i>Connect</i>	Ethernet (RJ45) cable between OTU-1 and Laptop.
S-1.2	<i>Perform</i>	IE Logon (Section 3.1)
S-1.3	<i>Set</i>	Set Commissioned Flag to False (Section 3.5)
S-1.4	<i>Perform</i>	IE Logout (Section 3.2)
S-1.5	<i>Disconnect</i>	Ethernet (RJ45) cable between OTU-1 and Laptop.
S-1.6	<i>Connect</i>	Ethernet (RJ45) cable between OTU-2 and Laptop.
S-1.7	<i>Perform</i>	IE Logon (Section 3.1)
S-1.8	<i>Set</i>	Set Commissioned Flag to False (Section 3.5)
S-1.9	<i>Perform</i>	IE Logout (Section 3.2)
S-1.10	<i>Disconnect</i>	Ethernet (RJ45) cable between OTU-2 and Laptop
S-2	OTU-1	
S-2.1	<i>Connect</i>	Short USB cable between OTU-1 and Laptop
S-2.2	<i>Connect</i>	Ethernet (RJ45) cable between OTU-1 and Laptop.
S-2.3	<i>Perform</i>	CamLAP Logon (Section 2.1)
S-2.4	<i>Perform</i>	Set OTU to Stare (Section 2.5)
S-2.5	<i>Perform</i>	CamLAP Logout (Section 2.2)
S-2.6	<i>Disconnect</i>	Short USB cable between OTU-1 and Laptop
S-2.7	<i>Disconnect</i>	Ethernet (RJ45) cable between OTU-1 and Laptop
S-3	OTU-2	
S-3.1	<i>Connect</i>	Short USB cable between OTU-1 and Laptop
S-3.2	<i>Connect</i>	Ethernet (RJ45) cable between OTU-1 and Laptop.
S-3.3	<i>Perform</i>	CamLAP Logon (Section 2.1)
S-3.4	<i>Perform</i>	Set OTU to Scan (Section 2.6)
S-3.5	<i>Perform</i>	CamLAP Logout (Section 2.2)
S-3.6	<i>Wait</i>	OTUs should acquire a Data Link within 10 minutes (Section 2.7)
S-3.7	<i>Verify</i>	Data link is up using CamLAP (Section 2.7)
S-3.8	<i>Disconnect</i>	Short USB cable between OTU-2 and Laptop
S-3.9	<i>Do not Disconnect</i>	Ethernet (RJ45) cable between OTU-2 and Laptop
S-4	OTU-2	
S-4.1	<i>Verify</i>	Ethernet (RJ45) cable between OTU-2 and Laptop.
S-4.2	<i>Perform</i>	IE Logon (Section 3.1)
S-4.3	<i>Set</i>	Set Commissioned Flag to True (Section 3.5)
S-4.4	<i>Perform</i>	IE Logout (Section 3.2)
S-4.5	<i>Disconnect</i>	Ethernet (RJ45) cable between OTU-2 and Laptop

S-5	OTU-1	
S-5.1	<i>Connect</i>	Ethernet (RJ45) cable between OTU-1 and Laptop.
S-5.2	<i>Perform</i>	IE Logon (Section 3.1)
S-5.3	<i>Set</i>	Set Commissioned Flag to True (Section 3.5)
S-5.4	<i>Perform</i>	IE Logout (Section 3.2)
S-5.5	<i>Disconnect</i>	Ethernet (RJ45) cable between OTU-1 and Laptop

Process Complete

2.4 OTU RESTART

When one OTU has been replaced without moving the other OTU, the RESTART method may be used.

S-1	Verify	Replacement OTU has its Commission flag set to False before initializing.
S-1.1	<i>Connect</i>	Ethernet (RJ45) cable between replacement OTU and Laptop.
S-1.2	<i>Perform</i>	IE Logon (Section 3.1)
S-1.3	<i>Set</i>	Set Commissioned Flag to False (Section 3.5)
S-1.4	<i>Perform</i>	IE Logout (Section 3.2)
S-1.5	<i>Do Not Disconnect</i>	Ethernet (RJ45) cable between OTU-1 and Laptop.
S-2	<i>Connect</i>	Short USB cable between replacement OTU and Laptop
S-3	<i>Verify</i>	Ethernet (RJ45) cable between replacement OTU and Laptop.
S-4	<i>Perform</i>	CamLAP Logon (Section 2.1)
S-5	<i>Select</i>	OTU Commands
S-6	<i>Select</i>	Acquire Link
S-7	ERROR	If you get the following message go to 2.4.6, else go to 2.4.12. “OTU Link must be Down If you wish to proceed, Use Recalibrate or Web Interface to set FSO Control to Admin Down”
S-8	<i>Select</i>	Recalibrate
S-9	<i>Wait</i>	While OTU searches for mirror limits and image stops moving (3 min)
S-10	<i>Increase</i>	step count 200 (Approx)
S-11	<i>Align</i>	Crosshairs near top left of peer OTU glass when viewed on CamLAP (use arrows)
S-12	<i>Select</i>	OTU Command
S-13	<i>Select</i>	Acquire Link

S-14	<i>Select</i>	Replacement
S-15	<i>Wait</i>	OTUs should acquire a Data Link within 10 minutes (Section 2.7)
S-16	<i>Perform</i>	CamLAP Logout
S-17	<i>Set</i>	Set Commissioned Flag to False (section 3.5)
S-18	<i>Perform</i>	IE Logout (Section 3.2)

2.5 SET OTU TO STARE

After performing a CamLAP Logon, perform the following:

S-1	<i>Verify</i>	Short USB cable between OTU and Laptop
S-2	<i>Connect</i>	Ethernet (RJ45) cable between OTU and Laptop
S-3	<i>Perform</i>	CamLAP Logon (Section 2.1)
S-4	<i>Select</i>	OTU Commands
S-5	<i>Select</i>	Acquire Link
S-6	ERROR	If you get the following message go to 2.5.7, else go to 2.5.11: “OTU Link must be Down If you wish to proceed, Use Recalibrate or Web Interface to set”
S-7	<i>Select</i>	Recalibrate
S-8	<i>Wait</i>	While OTU searches for mirror limits and image stops moving
S-9	<i>Increase step count</i>	200 (approx)
S-10	<i>Align</i>	Crosshairs to center of glass on peer OTU using arrows
S-11	<i>Select</i>	OTU Command
S-12	<i>Select</i>	Acquire Link
S-13	<i>Select</i>	New Application
S-14	<i>Select</i>	Stare
S-15	<i>Select</i>	OK
S-16	ERROR	If a Reposition Error message is given, Mechanically reposition the OTU so the peer is better centered in image span

Process Complete

2.6 SET OTU TO SCAN

After performing a CamLAP Logon, perform the following:

- | | | |
|------|---|---|
| S-1 | <i>Select</i> | <i>OTU Commands</i> |
| S-2 | <i>Select</i> | <i>Acquire Link</i> |
| S-3 | If you get the following message, go to 3.3.4, else go to 3.3.8:
“OTU Link must be Down
If you wish to proceed,
Use Recalibrate or Web Interface to set” | |
| S-4 | <i>Select</i> | <i>Recalibrate</i> |
| S-5 | <i>Wait</i> | While OTU searches for mirror limits and image stops moving |
| S-6 | <i>Increase step count</i> | 200 (approx) |
| S-7 | <i>Align</i> | Crosshairs to center of glass on peer OTU using arrows |
| S-8 | <i>Select</i> | <i>OTU Command</i> |
| S-9 | <i>Select</i> | <i>Acquire Link</i> |
| S-10 | <i>Select</i> | <i>New Application</i> |
| S-11 | <i>Select</i> | <i>Scan</i> |
| S-12 | <i>Select</i> | <i>OK</i> |

Process Complete

2.7 CHECK DATA LINK

Use this section to verify the data link between the two OTUs is up. When the data link is up, the two OTUs are communicating but may not be transporting any user data. Use the Verify Data Transfer test (Section 5.4) to check for actual data.

S-1 *Perform* **CamLAP Logon**

S-2 Stoplight color shows the data link status

Red	Link down
Green	Link up

S-3 *Perform* **CamLAP Logout**

Process Complete

3.0 **OTU OPERATIONS – INTERNET EXPLORER**

3.1 **IE LOGON**

Use the following procedure to Logon to the OTU Operating System via the Laptop to OTU Ethernet link.

S-1	CABLES	
S-1.1	<i>Connect</i>	Ethernet cable (RJ45) from OTU to Laptop
S-2	<i>Select</i>	Desktop
S-3	<i>Open</i>	Internet Explorer
S-4	<i>Type Address:</i>	Tower 1 <u>128.217.107.176</u> Tower 2 <u>128.217.107.177</u>
S-5	ERROR	If there is no prompt (username), the Ethernet link is down (Section B.1).
S-6	<i>Type Username:</i>	sysadmin
S-7	<i>Tab</i>	
S-8	<i>Type PW:</i>	sysadmin
S-9	<i>Select</i>	OK
S-10	SUCCESS	AirFiber 5800 title page is active

Process Complete

3.2 IE LOGOUT

Always logout to prevent the operating system from locking up.

S-1	CABLES	
S-1.1	<i>Verify</i>	Ethernet cable (RJ45) between OTU and Laptop
S-2	<i>Verify</i>	AirFiber 5800 Element Mgmt Sys is active
S-3	<i>Select</i>	File
S-4	<i>Select</i>	Close
S-5	CABLES	
S-5.1	<i>Disconnect</i>	Ethernet cable (RJ45) between OTU and Laptop
S-5.2	<i>Connect</i>	Service Ethernet cable between OTU and Laptop

Process Complete

3.3 CHECK OTU IP ADDRESS

The OTU's IP address must be within the same base address of the Laptop. Use this procedure to check the OTU's address.

S-1	<i>Perform</i>	IE Logon (see Section 3.1)
S-2	<i>Select</i>	System
S-3	<i>Select</i>	Config
S-4	<i>Verify</i>	Name Tower 1 or Tower 2
S-5	<i>Select</i>	System
S-6	<i>Verify</i>	IP Address Tower 1 <u>128.217.107.176</u> Tower 2 <u>128.217.107.177</u>
S-7	If incorrect, <i>Perform</i>	Change OTU IP Address (Section 3.4)
S-8	<i>Perform</i>	IE Logout (Section 3.2)

Process Complete

3.4 CHANGE OTU IP ADDRESS

Use Section 3.3 to check the OTU IP address. If incorrect, use the following procedure to change the OTU IP address

S-1	<i>Perform</i>	Check OTU IP Address (Up to step 3.3.5)	
S-2	<i>Type new address</i>	Tower 1	<u>128.217.107.176</u>
		Tower 2	<u>128.217.107.177</u>
S-3	<i>Select</i>	Save	
S-4	<i>Select</i>	Admin	
S-5	<i>Select Status:</i>	Reboot	
S-6	<i>Select</i>	Save	
S-7	<i>Wait</i>	Reboot takes about 5 min	
S-8	<i>Select</i>	DeviceView	
S-9	<i>Wait</i>	Until large light turns green indicating data link is up	
S-10	<i>Perform</i>	IE Logout (Section 3.2)	

Process Complete

3.5 SET COMMISSION FLAG (TRUE / FALSE)

After the data link has been established, the Commission flag must be set to TRUE to enable the units to automatically acquire a link following a power outage or other interruption to the link.

S-1	<i>Perform</i>	IE Logon (see Section 3.1)
S-2	<i>Select</i>	System
S-3	<i>Select</i>	Config
S-4	<i>Select</i>	System
S-5	<i>Set Commissioned flag</i>	True or False
S-6	<i>Select</i>	Save
S-7	<i>Select</i>	Admin
S-8	<i>Select Status:</i>	Reboot
S-9	<i>Select</i>	Save
S-10	<i>Select</i>	OK
S-11	<i>Wait 4 min.</i>	Reboot takes about 4 to 5 min
S-12	<i>Select</i>	IE Refresh Button
S-13	<i>Wait until</i>	AirFiber 8500 header returns
S-14	<i>Verify</i>	Commissioned value has changed
S-15	<i>Perform</i>	IE Logout (Section 3.2)

Process Complete

3.6 CHECK DATA LINK STATUS

Use this section to verify the data link between the two OTUs is up. When the data link is up, the two OTUs are communicating but may not be transporting any user data. Use the Verify Data Transfer test (Section 5.4) to check for actual data.

- S-1

Perform

IE Logon (see Section 3.1)
- S-2

View

Large light status

Red

Green

Data link is down

Data link is up
- S-3

Perform

IE Logout (Section 3.2)

Process Complete

4.0 OTU OPERATIONS – HYPERTERMINAL

4.1 HYPERTERMINAL LOGON - ETHERNET

Use the following procedure to Logon to the OTU Operating System via a HyperTerminal mode using the Laptop to OTU Ethernet link.

S-1	CABLES	
S-1.1	<i>Connect</i>	Ethernet cable (RJ45) from OTU to Laptop
S-2	Open HyperTerminal	
S-2.1	<i>Select</i>	Start
S-2.2	<i>Select</i>	Programs
S-2.3	<i>Select</i>	Accessories
S-2.4	<i>Select</i>	Communications
S-2.5	<i>Open</i>	HyperTerminal (with phone icon)
S-2.6	<i>Type</i>	Any name like FS1
S-2.7	<i>Select</i>	Any icon like first phone
S-2.8	<i>Select</i>	OK
S-2.9	<i>Select</i>	Connect Using: “TCP/IP (Winsock)”
S-2.10	<i>Type</i> Host address:	
		Tower 1 128.217.107.176
		Tower 2 128.217.107.177
S-2.11	<i>Select</i>	OK
S-3	Reply should be	Welcome to the craft interface shell
S-4	<i>Type</i> Username:	sysadmin
S-5	<i>Enter</i>	<CR>
S-6	<i>Type</i> Password:	sysadmin
S-7	<i>Enter</i>	<CR>
S-8	Prompt should be the OTU’s name	
		Tower1>
		Tower2>
S-9	For list of commands	
S-9.1	<i>Type</i>	enableSymbolCalls
S-9.2	<i>Type</i>	lkup “tt”
S-10	<i>Perform</i>	Other operations
S-11	<i>Perform</i>	Hterm Logout (Section 4.3)

4.2 HYPERTERMINAL LOGON – RS232

Use the following procedure to Logon to the OTU Operating System via the Laptop to OTU Ethernet link.

S-1	CABLES	
S-1.1	<i>Connect</i>	RS232 cable from OTU to Laptop
S-2	<i>Open HyperTerminal</i>	
S-2.1	<i>Select</i>	Start
S-2.2	<i>Select</i>	Programs
S-2.3	<i>Select</i>	Accessories
S-2.4	<i>Select</i>	Communications
S-2.5	<i>Open</i>	HyperTerminal (with phone icon)
S-2.6	<i>Type</i>	Any name like FS1
S-2.7	<i>Select</i>	Any icon like first phone
S-2.8	<i>Select</i>	OK
S-2.9	<i>Select</i>	Connect Using: “Com1”
S-2.10	<i>Select</i>	OK
S-3	Set the following:	
		Baud 9600
		Bits 8
		Parity None
		Stop Bits 1
		Flow None
		Select Apply
		Select OK
S-4	Reply should be	Welcome to the craft interface shell:
S-5	<i>Type</i> username	sysadmin
S-6	<i>Enter</i>	<CR>
S-7	<i>Type</i> PW	sysadmin
S-8	<i>Enter</i>	<CR>
S-9	Prompt should be the OTU’s name	
		Tower1>
		Tower2>

S-10	<i>For list of commands</i>	
S-10.1	<i>Type</i>	enableSymbolCalls
S-10.2	<i>Type</i>	lkup “tt”
S-11	<i>Perform</i>	Other operations
S-12	<i>Perform</i>	Hterm Logout (Section 4.3)
S-13	<i>Select</i>	File
S-14	<i>Select</i>	Exit
S-15	<i>Reply</i>	Save connection? No
Process Complete		

4.3 HYPERTERMINAL LOGOUT

Always logout of the system to prevent the operating system from locking up.

S-1	CABLES	
S-1.1	<i>Verify</i>	Ethernet cable (RJ45) or RS232 cable between OTU and Laptop
S-2	<i>Verify</i>	AirFiber 5800 Element Mgmt Sys is active
S-3	<i>Select</i>	File
S-4	<i>Select</i>	Close
S-5	<i>Type</i>	Logout
S-6	<i>Select</i>	File
S-7	<i>Select</i>	Exit
S-8	<i>Reply</i>	Save connection? No
S-9	CABLES	
S-9.1	<i>Disconnect</i>	Ethernet cable (RJ45) between OTU and Laptop
S-9.2	<i>Connect</i>	Service Ethernet cable between OTU and Laptop

Process Complete

4.4 CHANGE OTU IP ADDRESS

S-1	<i>Perform</i>	Hterm Logon - Ethernet Hterm Logon – RS232	(Section 4.1) or (Section 4.2)
S-2	<i>Perform</i>		
S-3	<i>Type</i>		
S-4	<i>Type Address:</i>	Tower 1 Tower 2	<u>128.217.107.176</u> <u>128.217.107.177</u>
S-5	<i>Select</i>		

4.5 MEASURE TRANSMIT & RECEIVE POWER

- | | | |
|------|------------------------------|--|
| S-1 | <i>Perform</i> | HyperTerminal LOGON – Ethernet or
HyperTerminal LOGON – RS232 |
| S-2 | <i>Type on prompt</i> | Tower 2> ttddump 1,1 |
| S-3 | <i>Enter</i> | <CR> |
| S-4 | <i>Scroll</i> | Back up to previous command to see Transmitter Power
“TxP (uw)” & Receiver Power “RxP (mV)” |
| S-5 | <i>Record the following:</i> | Date
Time
Sky conditions
Temperature (F)
Az
El
TxP (uw)
Range (from tape measurement; output value always shows
30)
RxP (mV) – Local
RxP (mV) – Remote |
| S-6 | <i>Type</i> | logout |
| S-7 | <i>Enter</i> | <CR> |
| S-8 | <i>Select</i> | File |
| S-9 | <i>Select</i> | Exit |
| S-10 | <i>On Prompt</i> | Do you want to save the connection “FS1”? |
| S-11 | <i>Select</i> | Yes |

Process Complete

4.6 CHECK DATA LINK STATUS

Use this section to verify the data link between the two OTUs is up. When the data link is up, the two OTUs are communicating but may not be transporting any user data. Use the Verify Data Transfer test (Section 5.4) to check for actual data.

- S-1

Perform

Hterm Logon (Section 4.1 or 4.2)
- S-2

View

Large light status

Red

Green

Data link is down

Data link is up
- S-3

Perform

IE Logout (Section 3.2)

Process Complete

5.0 **SMARTBITS OPERATIONS**

5.1 **SMARTBITS LOGON**

Use the following procedure to Logon to the SmartBits.

S-1 **CABLES**

S-1.1 *Connect* Ethernet cables from SmartBits to hub & hub to PC; or crossover Ethernet cable from SmartBits to PC

S-1.2 *Verify* PC on with Desk Top showing

S-2 *Open* **SmartApplication**

S-3 *Select* **Setup**

S-4 *Select* **SmartBits Connection**

S-5 If 128.217.107.28 is not a choice then step S-6 else S-9

S-6 *Select* **IP**

S-7 *Type IP* **128.217.107.28** Port 16385 (ATM)

S-8 *Select* **Add**

S-9 **Note:** Steps S-10 through S-13 are not needed when using the single ATM SmartBits

S-10 If 128.217.107.35 is not a choice then step S-11 else S-14

S-11 *Select* **IP**

S-12 *Type IP* **128.217.107.35** Port 16385 (Ethernet)

S-13 *Select* **Add**

S-14 *Verify* Each required IP address is selected (check mark)

S-15 *Select* **OK**

S-16 *Select* **Actions**

S-17	<i>Select</i>	Connect F8
S-18	<i>Verify</i>	IP addresses of interest are listed
S-19	<i>Select</i>	Connect

Figure 2-1 Process Complete

5.2 SETUP TEST LINKS

- S-1 *Verify* Hub,Slot,Port(s) of interest are shown in Source & Destination windows or in Test Pairs windows
- S-2 Source and Destination windows should now contain data cards
 01 = Gigabit (Ethernet) (OPTIONAL)
 05 = ATM (Used ATM cards only for FSO)
 NOTE: Gigabit goes away and 05 becomes 01 when only 1 SmartBits is used
- S-3 If Test Pairs window is blank, then step S-4, else step S-7
- S-4 *Select* Source **(05,17,01)¹ (01,17,01)²**
- S-5 *Select* Destination **(05,19,01)¹ (01,19,01)²**
- S-6 *Select* **>**
- S-7 *Select* Test Pairs **05,17,01 -> 05,19,02 (01,17,01 -> 01,19,02)²**
- S-8 *Disable* Bi-directional
- S-9 *Select* **1 to 1**
- S-10 *Repeat* following steps for **each** card shown halfway down page
- S-10.1 *Select* **ATM 017- (05-17-01) or ATM 018- (05-19-01)¹**

ECT-Ph2-Vol2-App-R0.doc

282

07/27/2006

¹ When using 2 SmartBits (ATM & Ethernet)

² When using only the ATM SmartBits

ATM 017- (01-17-01) or ATM 018- (01-19-01)²

S-10.2	<i>Verify Card Model</i>	AT-9622
S-10.3	<i>Set Connection Type</i>	PVC (Permanent Virtual Connection)
S-10.4	<i>Set VPI</i>	0
S-10.5	<i>Set VCI</i>	100 (0=virtual, 1-32 reserved, 33-16k)
S-10.6	<i>Set Encapsulation</i>	SNAP
S-10.7	<i>Set fill pattern</i>	All 0's
S-10.8	<i>Do not set</i>	Destination MAC 000000051301 (05,17,01) ¹ or 000000011301 (01,17,01) ² 000000051101 (05,19,01) ¹ or 000000011101 (01,19,01) ²
S-10.9	<i>Do not set</i>	SmartCard MAC 000000051101 (05,17,01) ¹ or 000000011101 (01,17,01) ²

ECT-Ph2-Vol2-App-R0.doc

283

07/27/2006

¹ When using 2 SmartBits (ATM & Ethernet)

² When using only the ATM SmartBits

000000051301 (05,19,01)¹ or
 000000011301 (01,19,01)²

S-11	<i>Select</i>	Line Parameters
S-12	<i>Verify</i> following defaults; change if necessary	
S-12.1	<i>Framing</i>	OC-12
S-12.2	<i>Loopback</i>	Disabled
S-12.3	<i>Tx Clk Source</i>	Internal
S-12.4	<i>Err Cell Handling</i>	Correct & Receive
S-13	<i>Set Cell Scrambler</i>	Enable
S-14	<i>Set Cell Host</i>	Enable
S-15	<i>Set Idle Cell Header</i>	00 00 00 00
S-16	<i>Select</i>	OK

Process Complete

5.3 SETUP TEST CONFIGURATION

S-1	<i>Select</i>	Setup
S-2	<i>Select</i>	Test Configuration
S-3	<i>Disable</i>	Use Custom
S-3.1	<i>Set Start from</i>	64
S-3.2	<i>Set Stop at</i>	1518
S-3.3	<i>Set Step size</i>	128
S-4	<i>Set Learning Mode to</i>	Once
S-5	<i>Set Learning Retries to</i>	3
S-6	<i>Select</i>	Throughput tab
S-7	<i>Set Duration (sec)</i>	10
S-8	<i>Set Number of Trials</i>	1
S-9	<i>Set Initial rate</i>	100 %
S-10	<i>Set Min rate</i>	0.1 %
S-11	<i>Set Max rate</i>	100 %
S-12	<i>Set Resolution</i>	0.5 %
S-13	<i>Select</i>	Packet Loss
S-14	<i>Set Duration (sec)</i>	10
S-15	<i>Set Number of Trials</i>	1
S-16	<i>Set Initial rate</i>	100 %
S-17	<i>Set Step rate</i>	5.0 %
S-18	<i>Set Max rate</i>	100 %
S-12	OK	

Process Complete

5.4 RUN TESTS

Note: Latency test is not valid for FSO

S-1	<i>Select</i>	Throughput button
S-2	<i>Wait</i>	while Throughput test run
S-3	<i>Select</i>	File
S-3.1	<i>Select</i>	Save As
S-3.2	<i>Enter</i> File name	T-mmddyy-tp (date)
S-4	<i>Raise</i> window up so tabs at bottom are visible	
S-5	<i>Select</i>	Packet loss tab
S-6	<i>Select</i>	Green light at top
S-7	<i>If asked</i>	
S-7.1	<i>Select</i> Save Results	Yes
S-7.2	<i>Enter</i> File name	T-mmddyy-tp (date)
S-7.3	<i>Select</i>	Save
S-8	<i>Wait</i>	while Packet Loss test runs
S-9	<i>Select</i>	File
S-9.1	<i>Select</i>	Save As
S-9.2	<i>Type</i> File name	T-mmddyy-pl (date)
S-9.3	<i>Select</i>	Save
S-10	<i>Select</i>	Yes
S-11	<i>Select</i>	File
S-12	<i>Select</i>	Exit
S-13	<i>Select</i>	File

S-14 *Select* **Exit**

S-15 Save Doc **Yes**

Process Complete

5.5 TYPICAL DATA

5.5.1 Throughput

Frame	%	Pks/Sec	Pks/Sec
64	100	1706415	1706415
192	100	282566	282566
320	100	201832	201832
448	100	141283	141283
576	100	108679	108679
704	100	94188	94188
832	100	78490	78490
960	100	67277	67277
1088	100	61427	61427
1216	100	54339	54339
1344	100	48718	48718
1472	100	45575	45575

5.5.2 Packet Loss

Frame	%	%
64	100	0
192	100	0
320	100	0
448	100	0
576	100	0
704	100	0
832	100	0
960	100	0
1088	100	0
1216	100	0
1344	100	0
1472	100	0

6.0 LAPTOP OPERATIONS

6.1 NOTES

The Laptop's IP address needs to be on the same subnet as the OTU IP address. Recommend the following settings:

IP Address	128.217.107.174	BH's Laptop or
	128.217.107.175	GB's Laptop
Subnet Mask	255.255.255.0	
Default Gateway	Optional (10.0.0.254 or blank)	

Process Complete

6.2 SET LAPTOP IP ADDRESS

To set the Laptop IP address compatible with the OTUs, use the following:

S-1	CABLES	Not required
S-2	<i>Select</i>	Start
S-3	<i>Select</i>	Settings
S-4	<i>Open</i>	Network Connections
S-5	<i>Select</i>	Local Area Connection
S-6	<i>Select</i>	Files
S-7	<i>Select</i>	Properties
S-8	<i>Scroll</i>	Down within “This Connection uses the following items:”
S-9	<i>Select</i>	Internet Protocol (TCP/IP)
S-10	<i>Select</i>	Properties
S-11	<i>Enter</i>	Following data:
	IP Address	128.217.107.174 BH’s Laptop or 128.217.107.175 GB’s Laptop
	Subnet Mask	255.255.255.0
	Default Gateway	Optional (10.0.0.254 or blank)
S-12	<i>Select</i>	OK
S-13	<i>Select</i>	Close
S-14	<i>Close</i>	Network Connection

Process Complete

6.3 CHECK LAPTOP IP ADDRESS

To check the Laptop IP address, use the above procedure or the following DOS commands:

S-1	CABLES	Not required
S-2	<i>Select</i>	Start
S-3	<i>Select</i>	Run
S-4	<i>Type</i>	Cmd
S-5	<i>Select</i>	OK
S-6	<i>Type</i>	ipconfig
S-7	<i>Enter</i>	<CR>
S-8	<i>View</i> Figure 2-2	Values under Ethernet adapter Local Area Network
S-9	<i>Close</i>	DOS window

Process Complete

6.4 **TURN OFF WI-FI**

Use the following procedure to turn off Wi-Fi while working with the OTUs:

S-1	CABLES	Not required
S-2	<i>Select</i>	Start
S-3	<i>Select</i>	Setting
S-4	<i>Open</i>	Network Connection
S-5	<i>Select</i>	Wireless Network Connection
S-6	<i>Select</i>	Disable this network device
S-7	<i>Select</i>	OK
S-8	<i>Select</i>	OK
S-9	<i>Close</i>	Network Connection

Process Complete

6.5 VERIFY COMMUNICATION LINK IS ESTABLISHED

S-1	<i>Select</i>	Start
S-2	<i>Select</i>	Run
S-3	<i>Select</i>	Open window
S-4	<i>Type</i>	ping 128.217.107.177 (or location of interest)
S-5	<i>Select</i>	OK
S-6	<i>If you receive a message</i> <i>Reply from 128.217.107.177:.....Then link is established</i> <i>If you receive a message</i> <i>Timeout.....Then link is not established</i>	
S-7	<i>Select</i>	Start
S-8	<i>Select</i>	Exit

Process Complete

APPENDICES

A. ACRONYMS

FSO	Free Space Optics
IE	Internet Explorer
IP	Internet Protocol
OC-3	Optical data rate of 155Mb/s (155.52 Mb/s = 3 x 51.84 Mb/s)
OC-12	Optical data rate of 622 Mb/s (622.08 Mb/s = 12 x 51.84 Mb/s)
OTU	Optical Transfer Units
Peer Unit	Opposite unit (OTU) in a 2-unit link
RS232	Transfer/Connector standard

B. PREVIOUS PROBLEM AREAS

B.1 OTU - Ethernet Link from Laptop to OTU is Down

- | | | |
|---------|--------------|--|
| B.1.1 | <i>Check</i> | IP address on OTU (Section 3.3) |
| B.1.2 | Check | IP address on Laptop (Section 6.1) |
| B.1.3 | Reboot OTU | |
| B.1.3.1 | Pull | Power to the OTU |
| B.1.3.2 | Wait | 1 minute |
| B.1.3.3 | Restore | Power to the OTU and allow it to reboot on its on. (5 min) |
| B.1.4 | Logoff | Laptop |
| B.1.5 | Restart | Laptop |

B.2 OTU - Check OTU name and/or IP address changed

- B.2.1 You may be logged on to the wrong tower. You can access the remote tower through the close tower when the FSO link is up.
- B.2.2 You may have changed the far tower while logged into the close tower.
- B.2.3 Reset IP addresses and names per instructions in Section

B.3 OTU - CAMLAP and IP Address do not Match

- B.3.1 Logging into CamLAP requires inputs over two cables
- B.3.2 The USB cable brings the image
- B.3.3 The RJ-45 connects to whichever IP address was specified.
- B.3.4 If the distance IP was entered by mistake and the link is up, the far OTU was accessed for link and IP data.
- B.3.5 Edit -> IP Address should show you the address of the tower requested over the RJ-45.

B.4 OTU - Error with USB Cable

- B.4.1 If when plugging in the USB extension cable to connect the camera to the Laptop, you receive an error message of the type:
 “USB Port does not have enough power Requirements exceeded”
- B.4.2 Try connecting the Laptop directly to the short USB cable (male) inside the rear access door of the OTUs.
- B.4.3 If this is successful, then your original USB extension cable is bad or too long. Try a shorter cable.

B.5 CamLAP - Lost Drivers

- B.5.1 If when trying to open CamLAP you get the following error messages:
 VideoOCX (VIDEO) – Driver cannot be connected
 VideoOCX (VIDEO) VFW not initialized (Call Init())
- B.5.2 Check the USB connection between the Laptop and the OTU (camera).
- B.5.3 Check to make sure the USB extension cable is not too long (Section 7.4)
- B.5.4 Check IP address of Laptop and set to same subnet per Section 5.1. Recommend the following:

IP Address	128.217.107.174 (Old: 10.0.0.11)	BH's
	128.217.107.175 (Old: 10.0.0.12)	GB's
Subnet Mask	255.255.255.0	
Default Gateway	blank	

- B.5.5 Check Ethernet link

- B.6 SmartBits – Framing Error
 - B.6.1 If when trying to operate SmartBits you get the following error messages:
Sonnet Framing Error
 - B.6.2 Check fiber connection to SmartBits. This is usually a physical problem

- B.7 SmartBits – No Cards Available Error
 - B.7.1 If when trying to operate SmartBits there are no cards available to select
 - B.7.2 Check if cards are reserved; if so, release cards
 - B.7.3 If cards will not release
 - B.7.4 Recycle power to SmartBits

C IP ADDRESSES

Device	Address	Description
SmartBits	128.217.107.28	ATM
SmartBits	128.217.107.35	Ethernet
Laptop	128.217.107.174	BH
Laptop	128.217.107.175	GB
OTU – AirFiber 8500	128.217.107.176	Tower #1
OTU – AirFiber 8500	128.217.107.177	Tower #2
Wi-Fi BaseStation		EDLLab (802.11b) Chn 11
Wi-Fi BaseStation	128.217.107.200	EDL-Lab1 (802.11b) Chn 6
Wi-Fi BaseStation	128.217.107.201	EDL-Lab2 (802.11b) Chn 7
Wi-Fi Access Point	128.217.107.202	EDL-Lab3 (802.11g) Chn 8

0REPORT DOCUMENTATION PAGE			<i>Form Approved</i> <i>OMB No. 0704-0188</i>	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188), Washington, DC 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE September 2003		3. REPORT TYPE AND DATES COVERED Technical Memorandum – 2003
4. TITLE AND SUBTITLE Emerging Communication Technologies (ECT) Phase 2 Report			5. FUNDING NUMBERS	
6. AUTHOR(S) Gary L. Bastin, William G. Harris, Robert Chiodini, Richard A. Nelson, PoTien Huang, David A. Kruhm				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) ASRC, ASRC-10, John F. Kennedy Space Center, FL 32815 NASA, YA-D7, John F. Kennedy Space Center, FL 32899			8. PERFORMING ORGANIZATION REPORT NUMBER NASA TM-2004-211522	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSORING/MONITORING AGENCY REPORT NUMBER NASA TM-2004-211522	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION/AVAILABILITY STATEMENT Unclassified – Unlimited Subject Category: Availability: NASA CASI (301) 621-0390			12b. DISTRIBUTION CODE Distribution: Standard	
13. ABSTRACT (<i>Maximum 200 words</i>) The Emerging Communication Technology (ECT) project investigated three First Mile communication technologies in support of NASA's Second Generation Reusable Launch Vehicle (2 nd Gen RLV), Orbital Space Plane, Advanced Range Technology Working Group (ARTWG) and the Advanced Spaceport Technology Working Group (ASTWG). These First Mile technologies have the purpose of interconnecting mobile users with existing Range Communication infrastructures. ECT was a continuation of the Range Information System Management (RISM) task started in 2002. RISM identified the three advance communication technologies investigated under ECT. These were Wireless Ethernet (Wi-Fi), Free Space Optics (FSO), and Ultra Wideband (UWB). Due to the report's size, it has been broken into three volumes: 1) Main Report 2) Appendices 3) UWB				
14. SUBJECT TERMS Range Information Systems, Advanced Communication, Wi-Fi, FSO, UWB, Ranges, Spaceports			15. NUMBER OF PAGES 552	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT	

